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C 17 (Prospects of creation and integration in the Urban Public Transport system).

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АЛМАТЫ МЕТРОПОЛИТЕННИҚ РАДИАЛ-САҚИНАЛЫҚ ЖЕЛІ

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РАДИАЛЬНО-КОЛЬЦЕВАЯ СЕТЬ АЛМАТИНСКОГО МЕТРОПОЛИТЕНА

(Перспективы создания и интеграции в систему городского общественного транспорта).

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The Book discusses issues of improving the availability of public transport in the Kazakhstan's largest city on the basis of the Metro intensive development. Planning features of the Almaty city and the specificity of the Public Transport functioning determine the optimal variant of the Metro development – the formation of a Radial-Ring network. Gradually implemented scheme of the Off-street transport forms convenient for passengers system of various types of Public and Private Transport integration. It helps to solve a significant number of existing and potential Transport problems, Socio-economic development tasks and Environmental problems in the city of Almaty.

The list of references includes 253 titles; going through the text illustrations are 31 Author's drawings. The Book is intended for specialists in fields of the Public Transport, the Urban Planning and the Environmental Protection.

В Монографии рассмотрены вопросы повышения доступности сети общественного транспорта крупнейшего города Казахстана на основе интенсивного развития Метрополитена. Планировочные особенности города Алматы и специфика функционирования различных видов общественного транспорта определяют оптимальный вариант развития Метро – формирование радиально-кольцевой сети. Поэтому реализуемая схема внеуличного транспорта формирует удобную для пассажиров систему интегрирования различных видов общественного и личного транспорта. Это позволяет решить значительное количество существующих и потенциальных транспортных проблем, задач социально-экономического развития и охраны окружающей среды в городе Алматы.

Перечень использованной литературы включает 253 наименований; в идущих по тексту иллюстрациях приведен 31 авторский чертеж. Книга предназначена для специалистов в области Общественного транспорта, Городского планирования и Охраны окружающей среды.

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Samoilov G.K., 2014

Dedicated to my Family, my teachers and colleagues.

Best Regards, Gleb K. Samoilov



Almaty, 2013



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INTRODUCTION

The topicality of the Problem

Functioning until the second decade of the new century, the public transport in Almaty in various stages of development was characterized by the interaction of several types of on-street transport. Buses, trolleybuses, trams, taxis alternately dominating in intercity passenger transportation. Since the mid 1930s, the main form of public transport was the tram. Ring-Radial circuit lines provide a possibility of not only a dozen radial and ring, but looping routes as well. Subsequent mass distribution of buses, and then trolleybuses has formed in conjunction with the extensive network of trams, provided almost complete coverage of the potential users of passenger transport services.

Existed since the middle to late twentieth century quite strict differentiation of the various streets determined the harmonious functioning of the system. The exceptions were a few express bus routes, the areas of marching parallel trolleybuses and, in rare cases, the tram lines. In this case, an express bus stops and taxi coincided with trolleybus stops only every three or four stops. Networks of interconnected modes evolved.

By the end of the Century the reduction of the number of public bus fleets and the proliferation of private transport companies led to the domination of the rolling stock of small capacity vehicles on traditional routes. Comfort of bench rolling trolleybuses and trams, in sharp contrast to the "boxes", has led to a redistribution of passenger traffic. The bulk of consumers began to use the services of electric transport, neglecting comfort to a low speed of transit. However, the long-term and costliness of the network development of trams and trolleybuses was not allowing to satisfy passenger demand. The optimal solution to the problem was the revision of the bus routes network: Part of routes were combined, some elongated, some removed. At the same time, many new routes have appeared.

At the same time the former on-street differentiation of various kinds began to break. Many of the new bus routes have duplicate trolleybus and tram routes. The combination on the same streets of different size, multivolume and multispeeded vehicles which was initially created did not cause difficulties to the road traffic. The problems started with a relatively quick replacement carried out by small capacity "boxes" to the multi-seat buses. The abundance of large-size vehicles, irreconcilability of maneuverability of buses trolleybuses, trams and especially complete coincidence stops along major complication has led to a dramatic road traffic situation in the city and the progressive reduction of comfort of services.

Currently, the Public transport system of the city is represented by two tram, nine trolleybus and one hundred eleven bus routes. Total number of units of public transport is 1823. Also there are about five hundred units of taxis in the city.

Initially Almaty Metro has opened the new stage in the development of public transport in the city. New country-type – off-street public transport – will significantly improve comfort and speed of travel. So, a trip to the station "Raiymbek Batyr" from station "Alatau" takes 14-16 minutes while the bus or trolley bus same trip takes from 25 to 30 minutes at the usual time and 40 to 50 minutes in the morning and evening rush hour. The ever-increasing passenger traffic on the eight kilometer stretch of the seven stations of the First stage of the underground ("Raiymbek Batyr" – "Zhlobek Joly" – "Almaly" – "Abai" – "Baikonur" – "Auezov Teatry" – "Alatau") allowed to proceed to optimization of the existing route network of ground public transport.

Municipality of Almaty city provided a multifaceted plan of development of transport infrastructure, including the anticipated launch of six control centers with turn-sites for urban and suburban routes. This will not only improve the performance of 21 city routes, but also will stop 45 suburban routes at the border. Given the organization of optimal interaction with the underground seventeen bus routes were already adjusted and four trolleybus routes.

The implementation of the Metro Development scheme will in the foreseeable future even more link bus and trolleybus routes with subway stations. In doing so, bus and trolleybus routes will be much shorter, connecting some parts of the city with one or two nearest metro stations. The resulting system is a kind of



"short route" will greatly enhance convenience for passengers, creating a subway integrated public transport network.

Well-functioning system of integrated public transport will significantly reduce the number of cars on streets of the city by reducing the number of buses, and by providing a convenient alternative to personal vehicles. This will make a significant contribution to the implementation of Strategy for Kazakhstan transition to "The Green economy" by the President of the Republic N.A.Nazarbayev [1].

The Degree of scrutiny of the Problem

Despite the fact, that the problems of development of different modes of transport, to improve their routing are constantly researched the topic for the past two centuries, they have attracted attention precisely at the turn of the century, when the ever-changing variety and multidirectional passenger flows have been increasingly caused many nodes slowdowns and even traffic jams.

General problems of urban public transport dedicated research specialists from different countries (P.Mees; V.Date; P.White; M.Schifelbusch; H.L.Dienel; G.T.Telliford; T.Laursen; B.Myers; C.Hass-Klau; G.Crampton; A.Ferlic; E.A.Ivanova; M.Bunting; A.Y.Mikhailov; I.P.Ryzhkov; C.Divall; W.Bond; J.Richmond; M.de Caro; Y.Amsler; B.Simpson; P.Laconte; M.Michael Ridley; E.Staisch; G.Ottley; J.Simmons; N.R.Bartlett; A.Rosenwald and others [2, 3, 4, 5, 6, 7, 8, 9 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32]). Considerable attention is paid to Management, Economic and Planning problems (M.Y.Elizariev; S.S.Kolobov; O.V.Bocharova; P.P.Volod'kin; D.Sh.Mustafin; M.R.Yakimov; R.Buehler; J.Pucher; G.Dudley; F.Mirabel; M.Reymond; H.K.Lo; T.Tsekeris; S.Voss; M.Aftabuzzaman; G.Currie; M.Sarvi; R.Gibson; A.Ljungberg; W.Veeneman; O.I.Larsen; J.Rekdal; D.P.Ashmore; A.D.Mellor; C.E.Cortes; A.Tirachini; D.A.Hensher; S.R.Jara-Diaz; N.Appleyard; J.Holmgren; T.I.Dubinin; A.A.Mogoras; A.T.Kiggundu; G.Abrate; M.Piacenza; D.Vannoni; H.Eyssartier; M.Dufoix; U.Crisalli; F.Cirianni; D.Ianno; R.Dorbritz; Y.M.Merov; I.M.Popova; I.V.Benedyk; H-M.Y.Eldarkhanov; V.P.Kozlova; A.S.Krupin; A.A.Kuanov; I.A.Mailov; I.A.Potekhin; A.L.Kiryanov; A.A.Sorokin; A.R.Vilents. and others [33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75]).

Special places in studies of public transport take in environmental issues (A.G.Basilaya, P.Khanna; R.Buehler; J.Pucher; V.U.Buznikov; M.Bell; S.H.Hosseinloo; U.Kanturska; R.Hickman; O.Ashiru; D.Banister; M.Konstantaki; E.Wickens; L.L.Abrzhina; R.G.Akhtyamov; M.V.Volkodaeva; V.N.Kurdukov; A.G.Zaprudin; V.V.Vasileva; O.A.Shadrina; O.V.Ryabova; J.N.Rizaeva; A.D.Zhdanov; N.I.Redikultseva; G.A.Chernova; V.I.Sarbaev; A.O.Sannik; K.Hunas; N.V.Kaverina; M.R.Yakimov; P.F.Agahanyants; N.S.Negrov; A.A.Perekladov and others [76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102]). Several studies reveal some aspects of the topic of this Research (L.Wright; G.Dydkowski; R.Tomanek; A.Piwonska; J.Koszelew; L.Too; G.Earl; D.Albalate; G.Bel; S.Farag; G.Lyons; D.Walton; S.Sunseri; P.White; M.Schifelbusch; M.P.Kane; R.Dunn; M.Joyce; P.Mees; K.Geurs; J.L.Moura; A.Ibeas; L.dell'Olio; J.C.Munoz; L.de Grange; R.Fare; B.S McMullen; D.W.Noh; K.C.Hu; M.N.Antonov; R.L.Branzia; S.M.Krapova; O.A.Pytaleva; P.Koster; K.Otto-Zimmermann; V.P.Sueiro; R.Van der Bijl; F.De Zeeuw; B.Aba; H.Bast; B.Ludwig; X.Yan; M.Wang; Q.Peng; D.Susniene; Z.Bazaras; V.Kleiza; U.Crisalli; F.Cirianni; D.Ianno; C.Mulley; J.D.Nelson; I.P.Dimova; A.S.Kharitonova; S.A.Korobov; M.L.Litvinenko; S.G.Mitrofanov; Y.K.Ponosov; V.N.Prokhorov; O.S.Semenova; C.D.Shavyraa; E.A.Zakiullina; L.L.Chumakov; E.V.Feklin; A.B.Kupriyanova; G.V.Mokhova; M.I.Sharov; A.A.Utkin; A.V.Zedgenizov; S.L.Chikalina; N.N.Shesterneva; E.S.Aksenova; O.N.Bakhtina; E.V.Belitskaya; G.V.Boyko; S.V.Danilov; J.A.Deshina; A.V.Grinchenco; M.I.Iliev; V.V.Khmelnitsky; E.E.Kravchenko; V.N.Prokhorov; A.M.Sataev; S.V.Sorokin; M.G.Sunina; Y.L.Vlasov; A.V.Belous; E.A.Ivanova; A.V.Kharchenko; N.A.Konycheva; J.G.Ptsareva; I.S.Radchenko; A.A.Sorokin; I.A.Ulyanovsky; S.V.Volodchenko; A.N.Makarevich; A.A.Papaskua; N.N.Sherchenkova; O.V.Popova; A.Y.Shonin; Y.A.Davidich and others [103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160,

161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183].

Especially important are issues of metro systems (G.K.Samoilov; S.Derrible; C.Kennedy; L.De la Calle; L.Orriols; F.Rienzo; P.Oreste; S.Pelizza; A.V.Kharchenko; R.S.Kudarov; J.J.Lin; C.W.Lo; V.A.Garber; E.P.Dudkin; O.J.Paraskevopulo; J.G.Paraskevopulo; C.A.Bulucea; C.Brandusa; V.M.Abramson; S.Y.Loubotski; J.Bartak; R.Schwandl; D.R.Beadman; A.Nordmark; M.C.Gumusoglu; Y.Erdem; T.Solak; D.S.Levanova; W.O.Assis; B.E.Milani; I.B.Vorobieva; U.Anttikoski; P.Sarkka; P.Eloranta; N.I.Kulagin; M.Robbins; R.Thornblom; J.-E.Bengtsson; D.M.Golitsynsky; N.I.Kulagin; G.E.Golubev; A.V.Kirdin; V.I.Smirnov; M.V.Smolova and others [184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214]).

However, although the theory and practice of the functioning of transport systems in various countries has a very deep study, the actual process of improvement in terms of priority of public transport in the Almaty city is insufficiently studied. The increasing intensity and recurring and to the increasing flows of temporary slowing of public and private transport in individual nodes indicate the need for in-depth study as factors contributing to this slowdown, and identify opportunities to eliminate or compensate for these slowdowns in different ways.

The need is to increase knowledge of the possibility of redistribution of passenger traffic by means of regulation, planning and spatial reorganization, and organizational and technical measures.

The Scientific novelty of this Research work

The above problems identified selection of the research topic, the scientific novelty of which is held for the first time in a systematic manner the study of the functioning of the existing system of the Public transport of the Almaty city, identifying and analyzing trends in the development of the Public transport with the possibility of redistribution of passenger traffic in the extensive network of off-street traffic.

The Hypothesis of this Research work

The existing Urban transport scheme is a direct reflection of its functional zoning, orientation and intensity of space-technology linkages, planning, social and cultural preferences in transportation and nomenclature and specifications of available vehicles. Accordingly, the Hypothesis of the Study is that the group identified the features of functioning of the transport scheme on the basis of typological and identifying emerging complexities of its operation in the aspect of direction and intensity of passenger traffic, the road network, the range and capacity of vehicles is sufficient to identify ways to optimize the transport scheme.

The Scientific-theoretical and Practical significance of this Research work

The Study has a specific scientific and theoretical and practical significance:

- Based on research by the author developed the theoretical and practical provisions which together solve a large and important in engineering, organizational planning, socio-cultural and environmental terms the problem of improving public transport of the Almaty city;

- Explored important aspects of the interaction of different modes of Public transport, which allows, going to the next level, to some extent, predict trends in the territorial scheme of public transport at the Almaty Conurbation;

- Deepened the degree of scrutiny of Public transport of all territory of the Republic of the Kazakhstan.

This determines the possibility of using the results in such areas as: design practice in the development of off-street transport and road network; improving the organizational and technical measures in the field of urban public transport; research works; the learning process for different transport's specializations.

The aim of the Study

The purpose of this study is to determine the main directions of the complex optimization of the urban integrated transport scheme on the example of the developed Almaty Metro Ring-Radial network.



Objectives of the Study

To achieve the objective of this study are to: emphasizing the factors that determine the functioning of the Almaty city Public transport; the study of existing conurbation's passenger flows on the parameters of their daily and seasonal focus and intensity; the study of the distribution of passenger flows on various modes of transport; the identification of possible directions of development of passenger traffic on the parameters changes their focus and intensity; the identification of promising typology of the Public transport in the City area.

Boundaries of the Study

The solution of Study tasks carried out in the following boundaries: Historically – limited to work abroad First and Second decade of the Twenty-first Century; Geographically – confined to the Almaty city area and the adjacent settlements of the Almaty Conurbation.

The object of the Study

As the object of the Study selected existing flow diagrams of different types of the Public and Private Transport and their functioning in a particular urban setting at the Almaty Conurbation.

Methods of studying

Used in the general scientific method of research is the dialectical way of learning from observations through a generalization to the practice.

In its context, are applied: the Integral-differential approach for dividing the data set on the basis of similarity of nodes and problems of the linear deceleration of flows of public transport, combine them in a typologically similar groups, reflecting the specificity of each of them; the Formal approach allowing tracing the development of various aspects of the problem for the selected chronological phases; the Iconographic approach allows us to investigate expression of features of different prototypes in the planning of specific organizational and technological circumstances; the Structural-semiotic approach, which allows simulating the development of different typological parameters.

The system and sequence of this Research work

Research methods identified the system and sequence of the Work: the selection and analysis of literature; the full-scale survey of the public transport system; the differentiation of the data; the comparison and analysis of characteristics; the formulation of the Author's Concept of improving the public transport system; the Text and Graphic interpretation of the Author's Conception; the testing of research results.

Testing and implementation of Research's results

Main provisions of the Research work were published in articles and online publications (List of Author's publications on the topic of the Research) and presented for discussion at the specialized Conference.

This Research Paper is the collection of new research results and practical proposals, which define acceptable at this stage **WAYS TO OPTIMIZE OF THE URBAN INTEGRATED TRANSPORT SCHEME, BASED ON DEVELOPED RING-RADIAL NETWORK OF THE METRO.**

THE AUTHOR EXPRESSES HIS GRATITUDE TO FOLLOWING ORGANIZATIONS:

- The British Library. – <http://www.bl.uk/>
- The Library of Congress. – <http://www.loc.gov/>
- The Russian State Library. – <http://www.rsl.ru/>
- The Scientific library of theses and abstracts "dissertCat". – <http://www.dissercat.com/>
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- The Society of Operations Engineers / The Institute of Road Transport Engineers – SOE IRTE. – <http://www.soe.org.uk/>
- The Transport Planning Society. – TPS. – <http://www.tps.org.uk/>
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- The Institute of Transportation Engineers. – ITE. – <http://ite.org/>
- The Japan Society of Civil Engineers – JSCE. – <http://www.jsce-int.org/>
- Verein Deutscher Ingenieure (The Association of German Engineers). – VDI. – <http://www.vdi.de/>
- The Transportation Research Board of the National Academies. – TRB. – <http://www.trb.org/>
- Trainclub.ru: Club of the railway and train journeys. – <http://trainclub.ru/>
- Amazines: Free Articles & Web Content. – <http://www.amazines.com/>
- Article Banker: Free Online Articles Directory. – <http://www.articlebanker.com/>
- Free Photos.bis: Free photos for business and personal use. – <http://www.free-photos.biz/>
- The SmartBrief Inc. – <http://www.smartbrief.com/>
- The Google Earth. – <http://www.google.com/earth/>
- The Wikipedia. The Free Encyclopedia. – <http://wikipedia.org/>
- The Wikimedia Commons. – <http://commons.wikimedia.org/wiki/>
- SkyscraperCity Forums. – <http://www.skyscrapercity.com/>
- QR Code Generator. – <http://qrcoder.ru/>

THE ALMATY METRO RING-RADIAL NETWORK
(Prospects of creation and integration in the Urban Public Transport system)
Research Paper by GLEB K.SAMOILOV, 2014

Chapter 1
**THE DEVELOPMENT
OF THE ALMATY METRO NETWORK**





1.1 Conceptions of the Almaty High-speed Off-street Transport tracing

The population growth and the territorial increase of the Almaty made the actuality of the Urban Rapid Transit development in the middle of the 20th century.

In the late 1950s, was planned construction of large residential areas to the West direction. This made actual task of creating a system of high-speed off-street traffic. The main route from new areas to the Urban center was considered the Arykovaia Street (the Abai Avenue, since 1960). In the zone of new construction along the South side of the Avenue was provided the corridor, which has a width about 80 meters (90 yards). In this corridor did not provide the new construction. Here eventually was supposed to build the Metro line at the shallow depth. This corridor (without high-rise buildings) still exists from the 6th-line Street to the Altynsar Avenue.

In the mid-1970s started designing of the High-speed passenger transport system on magnetic levitation (Скоростная пассажирская транспортная система – СПТС). The Project was approved in 1977: the "VNIIPItransprogress" («ВНИИПИтранспрогресс»), the Kazakh branch of the "PromtransNIIiproekt" (Казахское отделение «ПромтрансНИИпроект»); N.Karasiov – the Project Author, M.Lesovichenko – the Chief Project engineer. This was the Double-track Line on the viaduct over the roadway. The First stage (3.5 km): "Orbita" micro districts – along the Al-Farabi Avenue – along the Sain Street – the Abai Avenue. The Second stage (12 km): along the Abai Avenue – along the Mir Street (now the Zheltoksan Street) – the Railway station "Alma-Ata -2nd". Perspectives: the extension to the Railway station "Alma-Ata -1st" (8 km), extending to recreational areas "Kapshagay" (70 km); an offshoot to the Sport complex "Medeo" (17 km) [215, P.30; 216, P.44-45].

The history of the active development of the Metro in Almaty starts at the beginning of the 1980s. Government solutions have defined the procedure for design and construction (Order of August 4, 1980, № 1537p by the Council of Ministers of the USSR: the ensuring of the development of a Feasibility Study for the construction of the Almaty Metro in 1981-1982, and the inclusion of the Almaty Metro Design and Start of the Construction into the draft of the State Plan for 1981-1985) [185, P.7].

In 1981-1982, the "Metrogiprotrans" Institute («Метрогипротранс») with the participation of the "Lenmetrogiprotrans" Institute («Ленметрогипротранс») completed the First phase of the Almaty Metro project. The initial scheme of Metro lines (1981) consist of three lines [217].

The First Line - from the Avenue named after 50th anniversary of the October (now the Raiymbek Avenue) along the Furmanov Street to the Abai Avenue; along the Abai Avenue to the Sain Street – 11 stations, 3 interchange nodes: OCTIABR'SKAIA – GOGILEVSKAIA / DOSTYK since 1982 (the Interchange node with the Second line) – PANFILOVSKAIA / ALMALY since 1982 – FURMANOVA / ZHETYSU since 1982 – ABAIA / COMMUNISTICHESKAIA since 1982 – COSMONAVTOV / BAIKONUR since 1982 (the Interchange node with the Third line) – DZHANDOSOVA / TULPAR since 1982 – AUEZOVA / ALA-TAU since 1982 (the Interchange node with the Second line) – SAIRAN – PROSPECT "PRAVDY" – SAINA. Construction was supposed in two stages. The First stage – 7 stations: Octiabr'skaia, Dostyk, Almaly, Zhetysu, Communistcheskaia, Baikonur, Tulpar, Ala-Tau. The Second stage – 3 stations: Sairan, Prospect "Pravdy", Saina.

The Second Line (9 stations, 3 interchange nodes): from the Sain Street along the Obruchev Street (now Ryskulbekov Street) – turn on the Rozybakiev Street – along the Rozybakiev Street to the Satpaev Street – turn on the Abai Avenue – along the Abai Avenue – turn on the Auezov Street – along the Auezov Street to the Comsomolskaya Street (now the Tole Bi Street) – turn on the Gogol Street – along the Gogol Street to the Masanchi Street – turn on the Gorky Street (now Zhibek Zholy Avenue) – along the Gorky Street (now Zhibek Zholy Avenue) to the Park of Culture and Rest named after Gorky (now the Central Recreation Park).

The Third Line (7 stations, 2 interchange nodes): the intersection of the Lenin Avenue (now the Dostyk Avenue) and the Klochkov Street (now the Omarova Street) – the intersection of the Khadzhi Mukan Street and the Furmanov Street – the intersection of the Timiriazev Street and the Cosmonauts Street (now the Baitursynov Street) – along the Cosmonauts Street (now the Baitursynov Street) to the Pasteur Street (now the Makataev Street) – turn on the Tashkent Street (now the Raiymbek Avenue) – intersection of the Tashkent Street (now the Raiymbek Avenue) and Airfield Street (now the Bokeikhanov Street) – along the Tashkent Street (now the Raiymbek Avenue).

Four interchange nodes redistribute passengers – the Parallel type (1 point: the Ala-Tau station) and the Perpendicular type (3 points: the Baikonur Station, the Dostyk Station and the Station at the intersection of the Second and the Third line).

The Initial scheme of the Almaty Metro, 1981 is shown in the Figure 1.

In 1982-1983, K.Samoilov (G.Samoilov's father) performed the Research work "The Interchange node of the Subway in Alma-Ata city" (main provisions of this Study were published in 1992 [218]). He analyzed the size and the direction of passenger traffic at the "Baikonur" Station. On the basis of this analysis, was suggested to change the type of the interchange node at the Station – from the Perpendicular type to the Parallel type (such as was planned at the "Ala-Tau" station). Total elongation of both lines will be 2.0 km. However, an increase in construction cost is compensated for several years. The base of this compensation – a big size of the reduction of the time for passenger's interchanges from the one line to another line. Another aspect of the cost savings is that the United Station for two lines (the Parallel type) has two lobbies with escalators and elevators. Two independent stations (the Perpendicular type) have three or four lobbies with escalators and elevators.

By the end-1980s, the Initial plan for the development of the Metro network was supplemented – the First line was extended along the Suyunbai Avenue to the Railway Station "Alma-Ata - 1st", the Third line was extended along the Raiymbek Avenue to the Rozybakiev Street, and after rotated – along Tole Bi Street to the Kalkaman Micro District [219, P.160, 342-343]:

- the First Line (Red) – 15 stations, 3 interchange nodes: SAINA – SAIRAN – ABAIA – ALATAU (the Interchange node with the Second line) – TULPAR – BAIKONUR (the Interchange node with Third line) – PLOSHAD' RESPUBLIKI – ZHETYSU – ALMALY – DOSTYK (the Interchange node with the Second line) – OKTIABR'SKAIA – BOLSHOI ALMATINSKY KANAL – ROSCHA BAUMA – BOHDANA KHMELNITSKOGO – ALMA-ATA -1;

- the Second Line (Green) – 9 stations, 3 interchange nodes: ORBITA – KABLUKOVA – DZHANDOSOVA – ALATAU (the Interchange node with the First line) – AUEZOVA – COSMONAVTOV (the Interchange node with Third line) – AEROVOKZAL – DOSTYK (the Interchange node with the First line) – PARK GOR'KOGO;

- the Third Line (Blue) – 10 stations , 2 interchange nodes: KALKAMAN – AKSAI – AVTOVOKZAL – TASTAK – ESENTAI – COSMONAVTOV (the Interchange node with the Second line) – NICKOL'SKAIA – BAIKONUR (the Interchange node with the First line) – AL-FARABI – GORNY GIGANT.

The First line was supposed to continue from the Almaty-1st Railway Station to the Pervomaisky village and the Burundai village.

The scheme of the Almaty Metro, 1989 is shown in the Figure 2.

In 1990s-2000s, tracing scheme is gradually changing:

- the Third line is excluded (Kalkaman – Aksai – Avtovokzal – Tastak – Esentai – Cosmonavtov – Nickol'skaia – Baikonur – Al-Farabi – Gorny Gigant);

- the Ploshad' Respubliki station/ the Communisticheksaia station on the First line is excluded;

- the Second line is extended from the Recreation Park (the Park Gor'kogo station) to the Duman micro district;

- Interchange node of the First line and the Second line is transferred from the Alatau station to the Sairan station.

In the second half of the 2000s appeared some interesting proposals for the perspective development of the Metro network (two schemes for example).

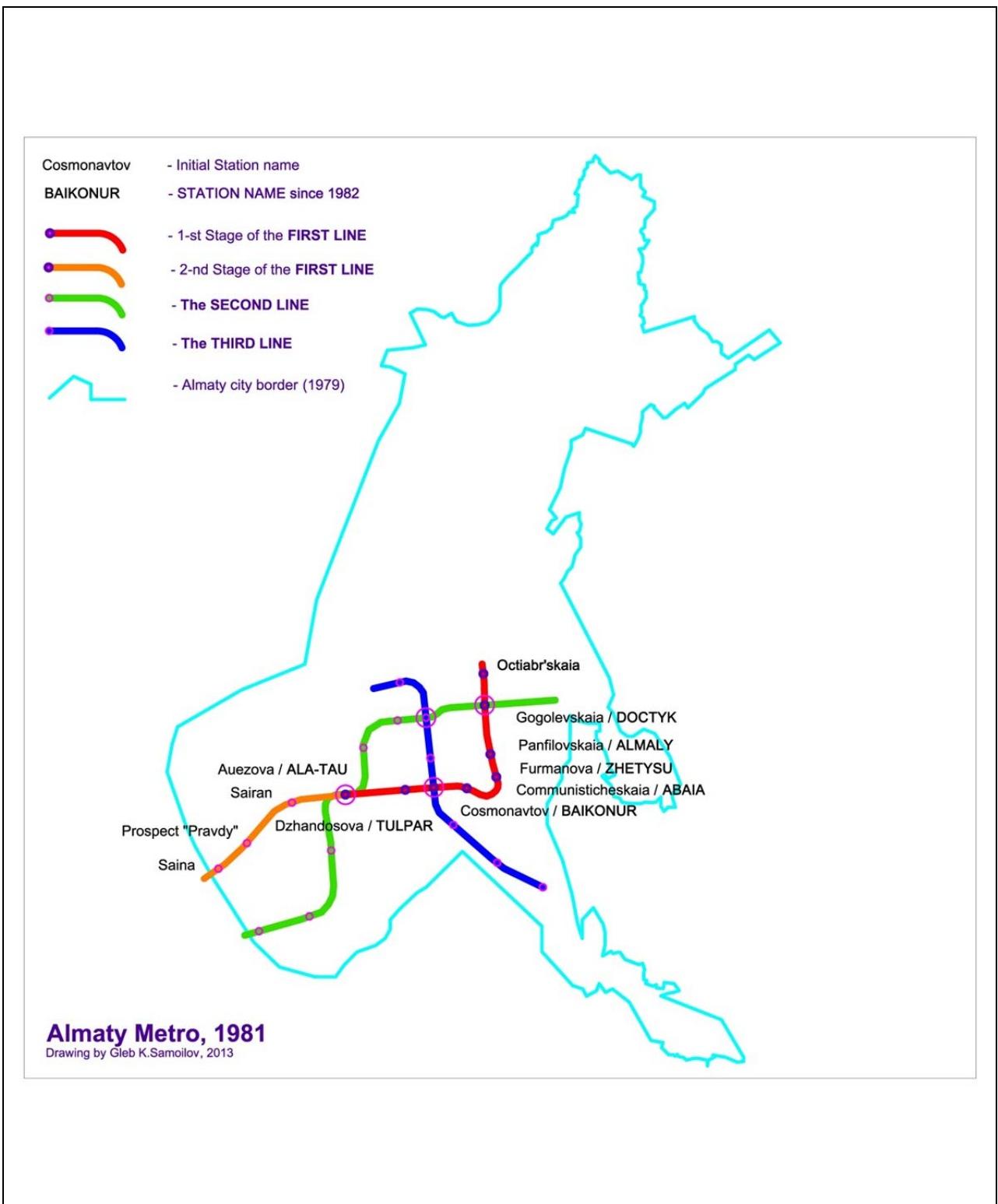


Figure 1.
 The Initial planned lines scheme of the Almaty Metro, 1981.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

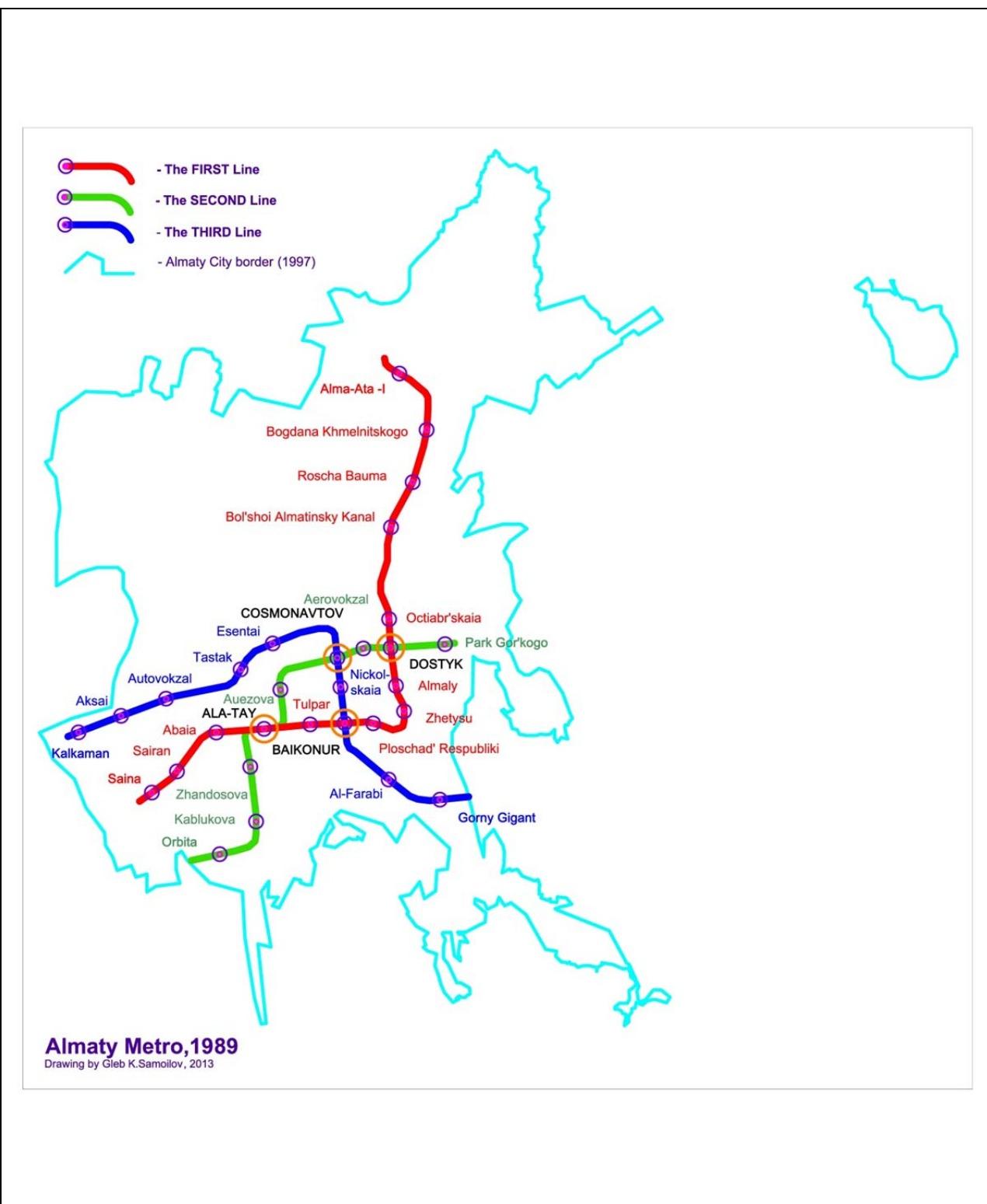


Figure 2.
The Planned lines scheme of the Almaty Metro, 1989.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

THE FIRST EXAMPLE – the Development of the Almaty Metro network (by “smpa” with “Solarama”’s proposals – “Skyscrapercity.com” Registered users, October 21st, 2007) [220]. Development Scheme is made on the basis of the project’s scheme, 1989:

- the First Line (16 stations; 6 interchange nodes): Zhetsu (the Interchange node with the Second Line) – Alatau (the Interchange node with the Second Line) – Tioschin Iazyk (the Interchange node with the Fourth Line) – Baikonur (the Interchange node with the Third Line) – Abai – Almaly – Zhibek Zholy (the Interchange node with the Second Line) – Raiymbek – Roscha Bauma – Elevator – Almaty-1st (the Interchange node with the Fourth Line) – Piatiletka Turksiba; the offshoot: Elevator – Altai – Airport; the offshoot: Altai – Zhuldus – GRES – to Baiserke.

- the Second Line (14 stations, 7 interchange nodes): Kalkaman (the Interchange node with the Fifth Line) – Aksai – Zhetsu (the Interchange node with the First Line) – Mamyr – Taugul’ – Orbita – Almagul’ (the Interchange node with the Fourth Line) – Alatau (the Interchange node with the First Line) – Tole Bi (the Interchange node with the Forth Line and with the Fifth Line) – Zhibek Zholy (the Interchange node with the First Line) – Park Gorkogo (the Interchange node with the Fourth Line) – Zhetsuiskaia – Malaia Stanitsa – Razvilk – to Talgar.

- the Third Line (10 stations , 3 interchange nodes): Kalkaman – Aksai – Avtovokzal – Tastak – Esentai – Cosmonavtov (the Interchange node with the Second line) – Nickol’skaia – Baikonur (The Interchange Node With The First Line) – Al-Farabi (the Interchange node with the Fourth Line) – Gorny Gigant – to Medeo.

- the Fourth Line (15 stations, 5 interchange nodes): Park Gorkogo (the Interchange node with the Second Line) – Samal – Finansovyj Tsentr (the Interchange node with the Third Line) – Kazakhfilm – Almagul’ (the Interchange node with the Second Line) – KazGU – Koktem – Tioschin Iazyk (the Interchange node with the First Line) – Tole Bi (the Interchange node with the Second Line and with the Fifth Line) – Tastak (the Interchange node with the Second Line and the Fifth Line) – Zaria Vostoka – Barakholka – Dorojnik – Ainabulak – Almaty-1st (the Interchange node with the First Line).

- the Fifth line (6 stations; 3 interchange nodes): Glavpochtamt – Tole Bi (the Interchange node with the Second Line and the Fourth Line) – Tastak (the Interchange node with the Fourth Line and the Fourth Line) – Sairan – Kalkaman (the Interchange node with the Second Line) – Priamoi Put’ – to Kaskelen.

THE SECOND EXAMPLE – “Fantasia on a Theme of the Almaty Metro” (by “niky_schneider” – “Skyscrapercity.com” Registered User, August 4th, 2009) [221]. Tracing of proposed lines virtually was ignored the real position of the Line, which was under construction at then time (8,56 km – the First Stage of the First Line: the Zharokov Street / the Abai Avenue – along the Abai Avenue – the Abai Avenue / the Tulebaev Street – along the Furmanov Street – the Furmanov Street / the Raiymbek Avenue):

- The First Line (15 stations, 5 interchange nodes): the Ryskulov Avenue / the Shemiakin Street – the Suiunbai Avenue / the – the Makataev Street / the Pushkin Street – the Dostyk Avenue / the Tjle Bi Street (the Interchange node with the Third Line) – the Dostyk Avenue / the Kurmangazy Street – the Abai Avenue / the Zheltoksan Street (the Interchange node with the Fifth Line) – the Baitursynov Street / the Satbaev Street – the Mukanov Street / the Abai Avenue – the Manas Street / the Zhandosov Street – the Aimanov Street / the Abai Avenue (the Interchange node with the Second Line) – the Abai Avenue / the Tlendiev Street (the Interchange node with the Fourth Line) – the Abai Avenue / the Altynsarın Avenue (the Interchange node with the Fifth Line) – the Abai Avenue / the Sain Street – the Abai Avenue / the Momyshuly Street – the Abai Avenue / the Karaganda Street.

- The Second Line (12 stations, 5 interchange nodes): the Seifullin Avenue / the Zhansugurov Street – the Seifullin Avenue / the Abylai Khan Avenue (the Interchange node with the Fifth Line) – the Seifullin Avenue / the Zhibek Zholy Avenue – the Gogol’ Street / the Isaev Street – the Bogenbai Batyr Street / the Auezov Street (the Interchange node with the Third Line) – the Gagarin Avenue / the Shevchenko Street – the Gagarin Avenue / the Mynbaev Street (the Interchange node with the First Line) – the Zhandosov Street / the Rozybakiev Street (the Interchange node with the Fourth Line) – the Zhandosov

Street / the Altynsar Avenue (the Interchange node with the Fifth Line) – the Zhandosov Street / the Sain Street – the Zhandosov Street / the Shaimerdenov Street – the Aksai Street / the Groza Street.

- The Third Line (12 stations, 5 interchange nodes): the Khaliulin Street / the Mendeleev Street – the Raiymbek Avenue / the Khamidi Street – the Gogol' Street / the Baribaev Street – the Zhandosov Street / the Shaimerdenov Street – the Tole Bi Street / the Dostyk Avenue (the Interchange node with the First Line) – the Abylai Khan Avenue / the Kabanbai Batyr Street (the Interchange node with the Fifth Line) – the Masanchi Street / the Bogenbai Batyr Street – the Tole Bi Street / the Zhumaliev Street – the Bogenbai Batyr Street / the Zharokov Street (the Interchange node with the Second Line) – the Tole Bi Street / the Torgut Ozal Street (the Interchange node with the Fourth Line) – the Tole Bi Street / the Utogen Batyr Street (the Interchange node with the Fifth Line) – the Tole Bi Street / the Sain Street – the Kulybekov Street / the Kazybekov Street.

- The Fourth Line (11 stations, 5 interchange nodes): the Dostyk Avenue / the Zholdasbekov Street – the Furmanov Street / the Al Farabi Avenue (the Interchange node with the Fifth Line) – the Al Farabi Avenue / the Shashkin Street – the Timiriazev Street / the Musrepov Boulevard – the Timiriazev Street / the Auezov Street – the Zhandosov Street / the Rozybakiev Street (the Interchange node with the Second Line) – the Abai Avenue / the Tlendiev Street (the Interchange node with the First Line) – the Turkebaev Street / the Shokarim Street – the Turgut Ozal Street / the Tole Bi Street (the Interchange node with the Third Line) – the Rozybakiev Street / the Raiymbek Avenue (the Interchange node with the Fifth Line) – the Moskwin Street / the Ryskulov Avenue.

- The Fifth Line (19 stations, 8 interchange nodes): the Dostyk Avenue / the Taimanov Street – the Dostyk Avenue / the Omarova Street – the Baiseitova Street / the Abai Avenue (the Interchange node with the First Line) – the Karasai Batyr Street / the Abylai Khan Avenue (the Interchange node with the Third Line) – the Gogol' Street / the Panfilov Street – the Raiymbek Avenue / the Abylai Khan Avenue (the Interchange node with the Second Line) – the Raiymbek Avenue / the Alekseev Street – the Raiymbek Avenue / the Kazakov Street – the Raiymbek Avenue / the Rosybakiev Street (the Interchange node with the Forth Line) – the Raiymbek Avenue / the Emtsov Street – the Utogen Batyr / the Tole Bi Street (the Interchange node with the Third Line) – the Utogen Batyr Street / the Zhurbanov Street – the Altynsar Avenue / the Abai Avenue (the Interchange node with the First Line) – the Zhandosov Street / the Timiriazev Street (the Interchange node with the Second Line) – the Gagarin Avenue / the Utegov Street – the Gagarin Avenue / the Dunaevsky Street – the Mustafin Street / the Toraigyrova Street – the Askarov Street / the Miras Street.

In the early 2010s the Development scheme of the Almaty Metro is complemented:

- the turn of the First Line to the "Almaty-1st" Railway station was deleted;
- the First line was extended to the Yntymak village; here formed the Combined station: the Metro station and the High-speed Railway station (the Station №8);
- the Third line is appeared: from the Station №8 – along the Severnoe Koltso Street – to the intersection with the Second Line (the Station №16 and the Station № 28).

On the 22nd of October, 2010 was issued the №1097 Decision of the Republic of Kazakhstan Government "ON THE MASTER PLAN OF ALMATY SUBURB ZONES (INTEGRATED SCHEME OF AREAS URBAN PLANNING)". The structure of this Regulation includes "Proposals for the development of high-speed passenger transport in suburbs": "Develop of the High-speed public passenger transport based on transport technologies such as: inside of the City – the Metro line and monorail systems; the Light Rail Transit (LRT) [...]; the Bus or the Trolleybus Rapid Transit (BRT). Subway lines provide of the connectivity of the Western [...] and the Northern areas of the City with its Historical and Business Center. The Master Plan provides for the construction LRT-lines in main areas and main compositional axis commuters: Almaty – Kapshagay "Zhana Ille", Almaty – Kaskelen – Shamalgan; Almaty – Talgar – Esik. [...] Formation of latitudinal transport axis East-West; Stage 1 (2015) – 13.8 km; Stage 2 (2020) – 40 km; Stage 3 (2040) – 14.5 km with the connecting of suburban areas in the future; on the Optimal period – 168 km. System BRT (Bus Rapid Transit) [...]: Stage 1 (2015) – 45 kilometers, Stage 2 (2020) – 65 kilometers, stage 3 (2040) – 45.5 kilometers [...]. BRT-routes with using trolley buses as rolling stock (about 50 kilometers) are laid in

straight transport corridors, which have the minimum number of intersections with similar modes of transport in one level. BRT-routes on the basis of bus transportation (120.0 kilometers) are laid in the peripheral areas along transport corridors [...]. Length of BRT-routes based on bus transportation to the outlet of the Almaty city in the suburban zone up to 110 km in 2015, to the Optimal period - 470 kilometers" [222] (*the Translate by the Author – G.S.*).

Simultaneously was performed "THE ADJUSTMENT OF THE CITY DEVELOPMENT PLAN IN TERMS OF THE TRANSPORT SCHEME". At the structure of this Document was included "The Routes Scheme of Public Transport speed kinds (LRT, BRT, Metro) 2040" (by "АЛМАТЫ ҚАЛА ҚҰРЫЛЫСЫ КАДАСТРЫ" ГКП, 2010 – "The Urban Cadastre of the Almaty") [223].

In 2011, the Light Rail Transit system begins to be actively developed. The First stage (the Planned line on existing tramways) – 13.8 km: the Momyshuly Street – the Tole Bi Street – the Baitursynov Street – the Makataev Street – the Zhetsu Street – the Raiymbek Avenue. But in terms of ease passenger traffic looks more promising the following Ring-Radial LRT-scheme for the First Stage of the Development (surface tracks and underground tracks):

- the DIAMETRIC LRT-Line ("The Lines Scheme of the Metro, Trams and LRT" by M.Golbraith, 2008 [224]) – along the Tole Bi Street (the New tram line: from the Kalkaman to the Momyshuly Street; the Existing tram line: from the Momyshuly Street to the Baitursynov Street; the Dismantled tram line: from the Baitursynov Street – through the Central part of the City – to the Kaiyrbekov Street; the New tram line: from the Kaiyrbekov Street – past the Park of the Culture and the Rest – to the Kok Tobe Recreation Zone);
- the RING LRT-Line – the Shevchenko Street / the Baitursynov Street / the Makataev Street / the Kunaev Street (the Existing tram line).

At the end of 2011 (the beginning of the Metro operation) was published the scheme of the future network development – "The Scheme of the Almaty metropolitan (2011)" [225]:

- planned lines – two sections of the FIRST LINE Second stage: along the Abai Avenue from the "Alatau" Station ("SAIRAN" – "MOSKWA" – "SARYARKA" – "DOSTYK" – "KALKAMAN") and along the Seifullin Avenue from the "Raiymbek Batyr" Station to the Railway Station "Almaty-1st" (5 stations: №№ 1, 2, 3, 4, 5);

- the planned line – the SECOND LINE (12 stations: №№ 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20). This line will connect Duman micro districts with Tastak district and the Orbita micro district. Interchange nodes of this Line: the station №17 / the "Sairan" station (the section of the FIRST LINE Second stage), the station №16 / the station №28 (the Line of the perspective development), the station №12 / the "Zhibek Zholy" station (the existing section of the FIRST LINE);

- two sections of the perspective development line: First section is the extending of the FIRST LINE Second stage from the Railway station "Almaty-1st" to the High-speed Railway station – the Route to the Kapshagai Recreation zone (3 stations: №№ 6, 7, 8*). Second section is Line from the station №28 to the station №8 will locate along the Northern Ring Street to the High-speed Railway station (9 stations: № 28, 27, 26, 25, 24, 23, 22, 21, 8*).

The scheme of the Almaty Metro, 2011 is shown in the Figure 3.

In 2013, for the Metro development was proposed the Radial-Ring scheme (the Concept by G.K.Samoilov; the first published – April 22, 2013 [226]): the Total number of stations 188; the Existing line (7 stations, 5 interchange nodes); the Constructed line (3 stations, 2 interchange nodes); Planned lines (37 stations, 24 interchange nodes); Proposed lines (139 stations, 59 interchange nodes). Features of this development scheme discussed in the following section of the Book.

The scheme of the Rind-Radial development for the Almaty Metro (the Concept by G.K.Samoilov, March, 2013) is shown in the Figure 4.

In mid-2013, according to published "The Scheme of the Almaty metropolitan" [227, 228], the further development consists of some sections:

- the Constructed line / the Continue of the FIRST LINE: along the Abai Avenue from the "Alatau" Station ("SAIRAN" – "MOSKWA");

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Research Paper by GLEB K.SAMOLOV, 2014



Figure 3.
Existing, Constructed and Planned lines of the Almaty Metro, 2011.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

THE ALMATY METRO RING-RADIAL NETWORK

(Prospects of creation and integration in the Urban Public Transport system)

Research Paper by GLEB K. SAMOILOV, 2014

10

THE ALMATY METRO DEVELOPED NETWORK POSITION OF EXISTING, CONSTRUCTED, PLANNED AND PROPOSED LINES

РАЗВИТАЯ СЕТЬ АЛМАТИНСКОГО МЕТРО

ПОЛОЖЕНИЕ СУЩЕСТВУЮЩЕЙ, СТРОЯЩЕЙСЯ, ПЛАНИРУЕМЫХ И ПРЕДЛАГАЕМЫХ ЛИНИЙ



Figure 4.
The Almaty Metro development proposal by G.K.Samoilov (March, 2013).

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K Samoilov (2013).

THE ALMATY METRO RING-RADIAL NETWORK
 (Prospects of creation and integration in the Urban Public Transport system)
 Research Paper by GLEB K.SAMOILOV, 2014

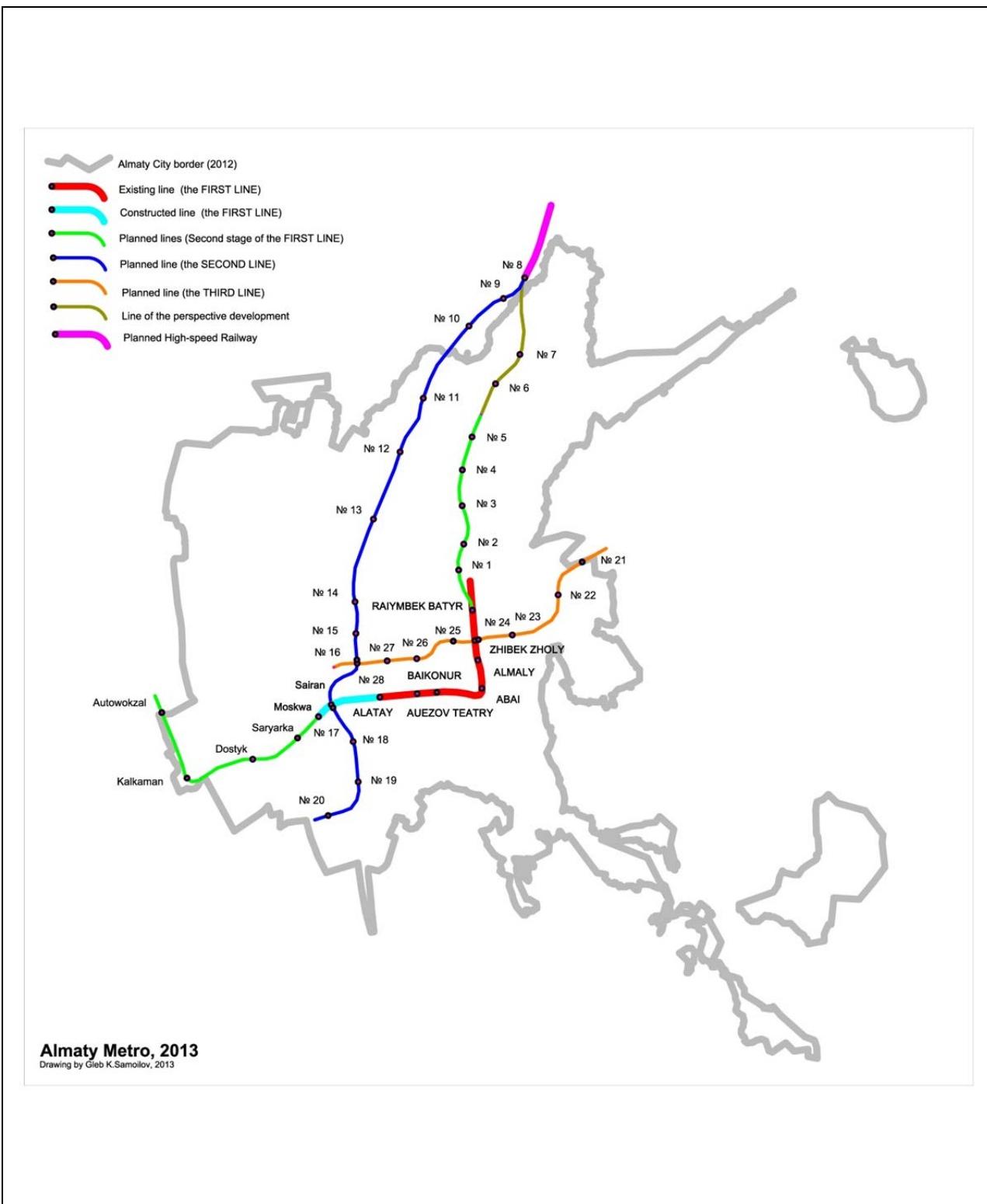


Figure 5.
Existing, Constructed and Planned lines of the Almaty Metro, 2013.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

- two sections of the FIRST LINE Second stage: along the Abai Avenue from the "Moskwa" Station ("SARYARKA" – "DOSTYK" – "KALKAMAN" – "AUTOWOKZAL") and along the Seifullin Avenue from the "Raiymbek Batyr" Station to the Railway Station "Almaty-1st" (5 stations: №№ 1, 2, 3, 4, 5) – this section of the Line will be on the overpass;

- the SECOND LINE (13 stations: №№ 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20). This line will connect Orbita micro districts with the High-speed Railway station (the Route to the Kapshagai Recreation zone). The section of the Line from the station №16 to the station №8 will locate along the Northern Ring Street. Interchange nodes of this Line: the station №17 / the "Sairan" station (the FIRST LINE), the station №16 / the station №28 (the THIRD LINE), the station №8 – the Combined station: the Metro station of two lines and the High-speed Railway station;

- the THIRD LINE (8 stations: № 28, 27, 26, 25, 24, 23, 22, 21). This line will connect the Tastak district with the Duman micro district. Interchange nodes of this Line: the station №24 / "Zhibek Zholy" (the FIRST LINE) and the station №28 / the station №16 (the SECOND LINE);

- the Perspective development (3 stations: №№ 6, 7, 8*) – extending of the FIRST LINE from the Railway station "Almaty-1st" to the High-speed Railway station.

The scheme of the Almaty Metro, 2013 is shown in the Figure 5.

In 2013, the Bus Rapid Transit system begins to be actively developed. The First stage (the BRT Planned line): the new West Bus Station – along the Raiymbek Avenue – the new East Bus Station.

At the end of 2013 was presented "THE STRATEGY FOR SUSTAINABLE TRANSPORT ALMATY FOR 2013-2023 YEARS", which proposed the creation of an integrated public transport system including the BRT, the LRT and the Metro [229].

1.2 Prerequisites for the formation of the Almaty Metro Ring-Radial network

Geographical features of the location of key elements of the external and internal public transportation, residential districts and working areas, places of mass recreation and entertainment, shopping and educational facilities, stadiums and health-sports centers, historical sites and precious natural landscapes of the Almaty determine the acceptable type of Metro scheme. In international practice for similar situations with the polycentric location of objects had successfully applied Ring-Radial schemes. These schemes are often used in the international practice of metro building. In most cases the Metro – it's a combination of ground and underground lines. Ground and underground lines have different lengths. For example, such work successfully Metros. Some Metros with existing, constructed and planned Ring-Radial schemes.

Two ring lines:

- The MADRID's Metro ("Metro de Madrid") has a length of 310 km, the number of lines – 16 and the number of stations – 320. [230].
- The BEIJING's Metro ("Beijing Ditie") has a length of 465 km, the number of lines – 17 and the number of stations – 270 [231].
- The MOSCOW's Metro ("Moskowski Metropoliten") has a length of 321 km, the number of lines – 12 and the number of stations – 192. Prospected Second (large) Ring [232].

One Ring line:

- The BERLIN's Metro ("U-Bahn Berlin") has a length of 152 km, the number of lines – 10 and the number of stations – 173 [233].
- The SHANGHAI's Metro ("Shanghai Ditie") has a length of 538 km, the number of lines – 14 and the number of stations – 329 [234].
- The SEOUL's Metro ("Seoul Metropolitan Subway") has a length of 394 km (with commuter lines – 975 km), the number of lines – 18 and the number of stations – 429 [235].

- The NAGOYA's Metro ("Nagoya Shiei Chikatetsu") has a length of 151,9 km, the number of lines – 7 and the number of stations – 83 [236].
- The NAPOLI's Metro ("Metropolitana di Napoli") has a length of 91,5 km, the number of lines – 8 and the number of stations – 83 [237].
- The DAEJEON's Metro ("Daejeon Metropolitan Subway") has a length of 22,6 km, the number of lines – 1 and the number of stations – 22. At the Daejeon Metro in addition to a single Radial line ("Banseok – Panam") is constructed Ring line (through stations: YuseongSpa, Seodaejeonnegeori, Dae-dong) [238].
- The DUBLIN's Metro ("Meitreo Átha Cliath") now has a length of 42,0 km, the number of lines – 2 and the number of stations – 34. The original decision on the Metro development set out in the Plan "Transportation 21": 2010 – Metro West Phase 1 (Tallaght to Clondalkin); 2011 – Metro West Phase 2 (Clondalkin to Lucan); 2012 – Metro West Phase 3 (Lucan to Blanchardstown); 2013 – Metro North; 2014 – Metro West Phase 4 (Blanchardstown to Ballymun) [239].
- The GLASGOW's Metro ("Glasgow Subway") is the most precise Ring-Radial scheme. It has an Underground Ring line length of 10,4 km. In this line placed 15 stations. Underground Ring line is integrated with the ground Radial lines of Suburban Rail. Interchange nodes are three stations: "Patrick", "Buchanan Street" and "Saint Enoch" [240].

At the stage of concept development – one or two ring lines for the Washington Metro [241; 242; 243], Ring line for the Copenhagen Metro [244], Ring closure at the Singapore Subway (Circle MRT Line) [245] and Ring line for the St. Petersburg Metro [246].

In World practice metros with Ring-Radial scheme the train with passengers runs only on one line. There are technological maneuver trains from one line to another without passengers. The movement of the train with passengers from the line to line is possible in principle, but its practical application – is a rare phenomenon. The motion of the train with passengers on the entire Metro network does not apply. The partial overlapping of individual radial routes and the ring route is used in the Melbourne metro.

In some countries, the optimal distance between Public transports stopping points are regulated, for example, Republic of Kazakhstan Building Rules and Regulations (СНиП), Chapter 3.01-01-2008* Urban planning. Layout and development of urban and rural communities; Paragraphs 11.17; 11.18; 11.19:

"11.17 Density of terrestrial transmission network of Public Passenger Transport on the built-up areas needs to be taken depending on the functional use and intensity of passenger flow, usually in the range 1.5-2.5 km/sq.km. In the central districts of Large cities and the largest density of this network is allowed to increase to 4.5 km/sq.km.

11.18 Range pedestrian approaches the nearest public passenger transport should take no more than 500 m, this distance should be reduced in the IV Climatic Subareas to 400 m. In the citywide walking distance of the Center approaches the nearest public passenger transport facilities from mass visits should be no more than 250 m in the Industrial and Communal storage areas – less than 400 meters from the walk-through businesses, in areas of Public recreation and Sport – less than 800 m from the main entrance. In complex terrain, with no special lifting specified distance passenger transport should be reduced by 50 m per 10 m elevation difference Crossing.

Notice. In areas where Individual villa building in the range of pedestrian approaches the nearest bus stop can be increased in Large cities and Major towns up to 600 m, and Small towns and Medium towns – up to 800 m.

11.19 The distances between the stopping points on the lines of public transport within the territory of settlements should be taken: for buses, trolley buses and trams – 400-600 m , express buses and high-speed trams – 800-1200 m , underground – 1000-2000 m, electrified railways – 1500-2000 m" (*the Author's translation – G.S.*) [247].

Analogical parameters are specified in operating Design Regulations of the Russian Federation (СНиП 2.07.01-89* [248]). In North America they are given as guidelines, which vary from state to state [249; 250].

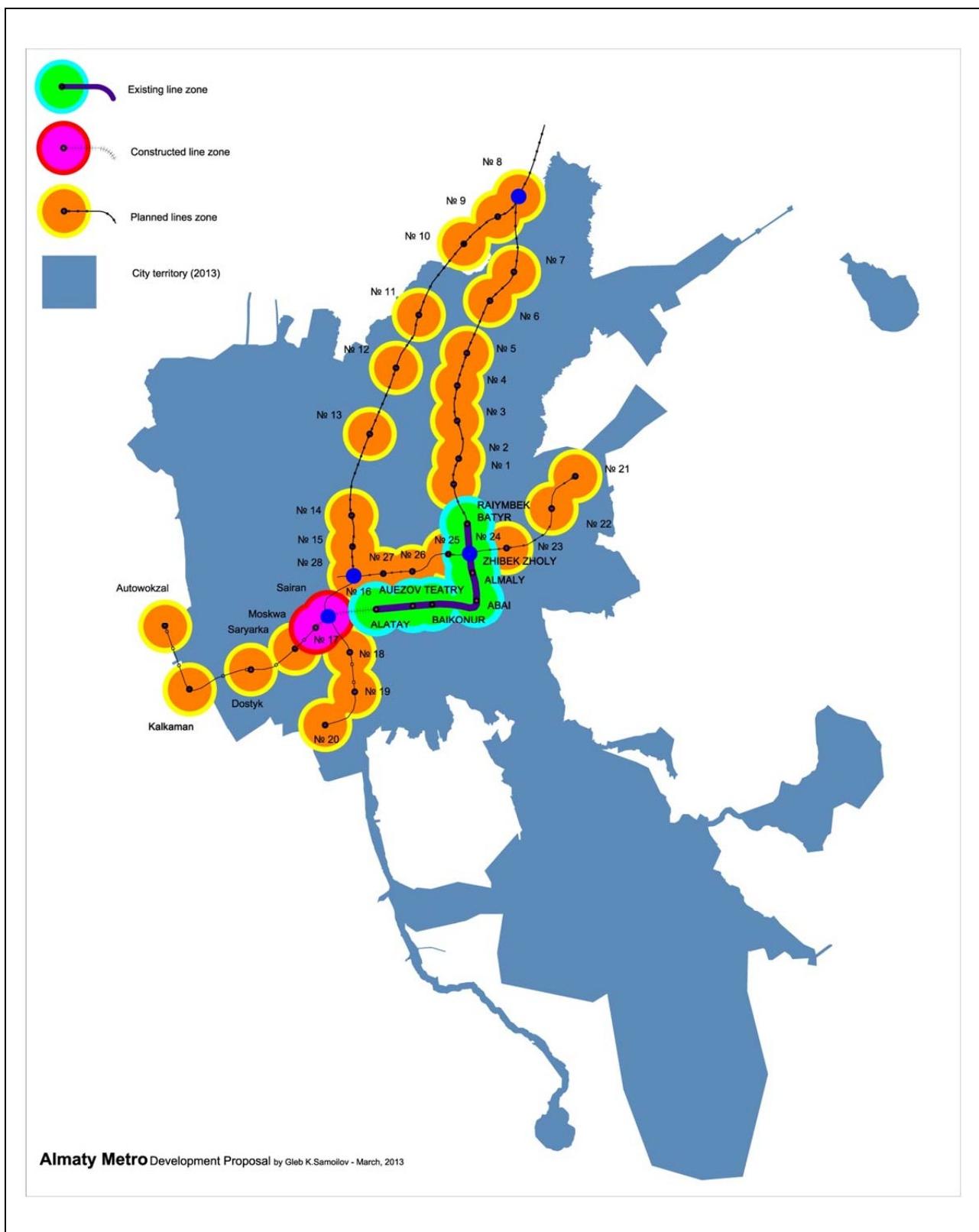


Figure 6.
Optimal accessibility zones of the Almaty Metro network: Existing, Constructed and Planning lines (1,0 km / 0,62 mi to the station).

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

Table 1.
WALKING DISTANCES TO PUBLIC TRANSPORT STATIONS IN URBAN AREAS
*(the Republic of the Kazakhstan; the Russian Federation;
 the United States of America; the Canada).*

Countries	Bus stops		Express Buses		Metro	
	Crow-fly (m)	Walking (m)	Crow-fly (m)	Walking (m)	Crow-fly (m)	Walking (m)
1	2	3	4	5	6	7
The Republic of the Kazakhstan [247]	200 - 300	500 (under different conditions: 250; 300; 400; 600; 800)	400 - 600	N/A	500 - 1000	N/A
The Russian Federation [248]	200 - 300	500 (under different conditions: 250; 300; 400; 600; 800)	400 - 600	N/A	500 - 1000	N/A
The United States of America [249; 250]	N/A	400 – 800	N/A	400 - 800	N/A	524 (average)
The Canada [249; 250]	N/A	300 – 900	N/A	300 - 900	675 (average)	492 (average)

The World practice of Metro systems operation shows that convenient for passengers distance to Metro station – 1.00 km / 0.62 miles. This corresponds to: 15 minutes of Walking; 5 minutes on the Scooter; 4 minutes on the Bicycle; 3 minutes on the Bike; 2 stops by Bus. However, the existing network of the Almaty Metro does not cover all potential passengers even by crow-fly distances.

The Zone of optimal accessibility of the Almaty Metro network: Existing, Constructed and Planning lines (1,0 km / 0,62 mi to the station) is shown in the Figure 6.

Average approximate values by different countries are given in the Table 1.

Those are next sites as: the Southern part of the City (residential areas, administrative and public facilities, recreation areas), the Airport area, new residential areas in the North-West. Prospects for increasing the Almaty city necessitate a significant expansion of the Subway network. One example of solution to this problem – the formation of Ring-Radial Metro network – it's the Tyne and Wear Metro development proposals by Author – G.K.Samoilov [186; 187].

1.3 Proposed scheme of the Almaty Metro Ring-Radial network

Further development of the Almaty Metro network is appropriate to maintain the radial-ring scheme. The base of the development proposal is the Main scheme of Existing, Constructed and Planned lines (Figure 3) with small changes:

- 7 additional stations (*between the ALATAY station and the SAIRAN station on the Constructed Line; between the SARYARKA station and the DOSTYK station on the Planned line; between the ZHIBEK ZHOLY station / the Station №24 and the Station №23 on the Planned line; between the Station №22 and the Station №23 on the Planned line; between the Station №5 and the Station №6 on the Planned line; between the Station №13 and the Station №14 on the Planned line; the Station behind the Station №28 on the Planned line*) – the reason of changes: they stations are interchange nodes of the proposed network and significant marked centers;
- the change of the Station position between lines (*from the AUTOVOKZAL station – the Ending station of the Planned line to the SURANSHY BATYR KOSHESI station – the Ending station of the Proposed line*) – the reason of changes: the shortening of distance from the Line Ending station to Central part of the City;
- changes of lines connection (*sectors of tracks between the Station №17 and the Station №16 / the Station №28 on planned lines*) – the reason of changes: the Line “ORBITA – SAIRAN – TASTAK – TOLE BI KOSHESI – ZHIBEK ZHOLY – KOK BASAR – DUMAN” with stations №20 – №19 – №18 – №17 – the Additional station – №28 – №27 – №26 – №25 – №24 – the Additional station – №23 – the Additional station – №22 – №21 has more size of the Daily passenger traffic than the Line “ORBITA – SAIRAN – TOLE BI KOSHESI – SEVERNOE KOLTSO KOSHESI – KARASU – YNTYMAK” with stations №20 – №19 – №18 – №17 – №16 – №15 – №14 – the Additional station – №13 – №12 – №11 – №10 – №9 – №8, which has the large Week-end passenger traffic (The similar scheme was topical in 2011, for example [225]).

New lines Basis of the configuration are following principles: the interchange node - two stations of two lines; the location of the stations on the straights (predominantly); the minimum radius of curves – 600 meters. *Names of new stations are relative (from surrounding streets).*

According to this concept developed network of the Almaty Metro is as follows. The total number of stations 188; the Existing line (7 stations, 5 interchange nodes); the Constructed line (3 stations, 2 interchange nodes); 4 Planned lines (37 stations, 24 interchange nodes); 8 Proposed lines (139 stations, 59 interchange nodes):

- the Existing Line (7 stations, 5 interchange nodes): Raiymbek Batyr– Alatay (8 km / 4,97 mi);
- the Constructed Radial Line – the Continuation of the Existing Line (3 stations, 2 interchange nodes): Alatay – Moskwa (3 km / 1,86 mi);
- the 1st Planned Radial Line – the Continuation of the Existing Line (9 stations, 6 interchange nodes): Raiymbek Batyr – Yntymak (20 km / 12,43 mi);
- the 2nd Planned Radial Line – the Continuation of the Constructed Line (4 stations, 1 interchange node): Moskwa – Kalkaman (8 km / 4,97 mi);
- the 3rd Planned Radial Line (15 stations, 10 interchange node): Orbita – Duman (24 km / 14,91 mi);
- the 4th Planned Line (9 stations, 7 interchange node): Tole Bi koshesi – Yntymak (22 km / 13,67 mi);
- the Proposed Ring RED Line (26 stations, 18 interchange nodes): *Almaty-Auezhai – Koktobe – Taugul’ – Shanyrak – Wokzal Almaty-1* (68 km / 42,25 mi);
- the Proposed Radial BLUE Line (18 stations, 10 interchange nodes): Suranshy Batyr koshesi – Ibragimov koshesi (48 km / 29,83 mi);
- the Proposed Radial GREEN Line (24 stations, 12 interchange nodes): Kyrgauldy – Otegen Batyr (50 km / 31,07 mi);
- the Proposed Radial ORANGE Line (20 stations, 9 interchange nodes): Almalybak – Kyzylkairat (46 km / 28,58 mi);
- the Proposed Radial BROWN Line (13 stations, 8 interchange nodes): Batysshil Saiabak – Remizovka (26 km / 16,16 mi);

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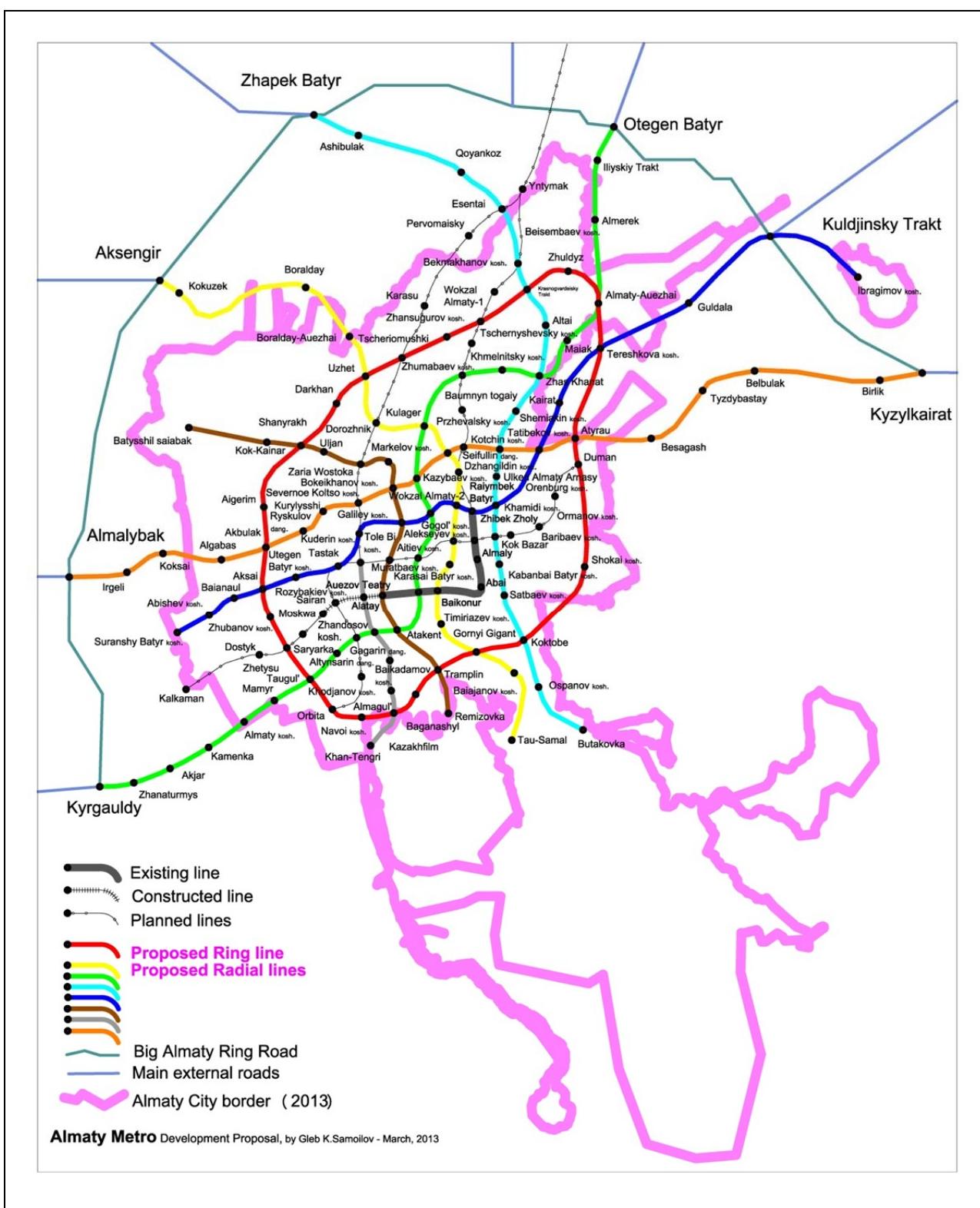


Figure 7.
The Conception of the Almaty Metro Development
(the Map).

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

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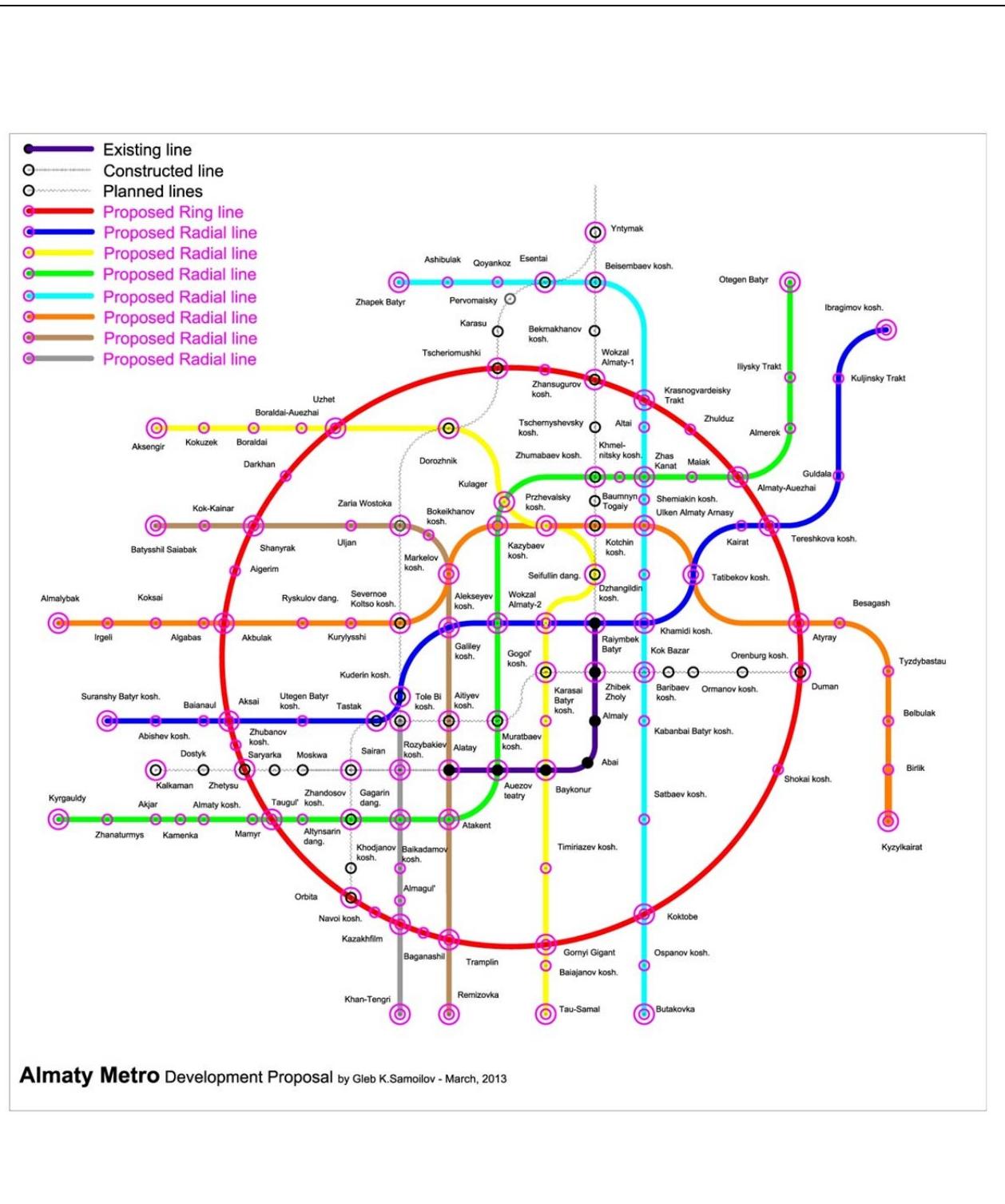


Figure 8.
The Conception of the Almaty Metro Development
(the Scheme).

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

- the Proposed Radial **YELLOW Line** (17 stations, 9 interchange nodes): Aksengir – Tau-Samal (37 km / 22,99 mi);

- the Proposed Radial **CELADON Line** (18 stations, 8 interchange nodes): Zhapek Batyr – Butakovka (40 km / 24,85 mi);

- the Proposed Radial **GREY Line** (7 stations, 4 interchange nodes): Tole Bi koshesi – Khan-Tengri (10 km / 6,21 mi).

One (the “Blue”, the “Yellow”, the “Celadon”) or both (the “Green”, the “Orange”) Endpoints of proposed radial Metro lines (with the exception of the “Grey” and the “Brown”) linked to the Line of the Big Almaty Ring Road – “БАКАД” [251, 252].

The Conception of the Almaty Metro Development (the Map) is shown in the Figure 7.

The Conception of the Almaty Metro Development (the Scheme) is shown in the Figure 8.

THE EXISTING LINE (7 stations, 5 interchange nodes): Raiymbek Batyr (*the Interchange node with the Planned Radial Line and with the Proposed Radial BLUE Line*) – Zhibek Zholy (*the Interchange node with the Planned Radial Line*) – Almaly – Abai – Baykonur (*the Interchange node with the Proposed Radial YELLOW Line*) – Auezov teatry (*the Interchange node with the Proposed Radial GREEN Line*) – Alatay (*the Interchange node with the Constructed Line and with the Proposed Radial BROWN Line*).

THE CONSTRUCTED RADIAL LINE – the Continuation of the Existing Line (3 stations, 2 interchange nodes): Alatay (*the Station of the Existing Line, the Interchange node with the Proposed Radial BROWN Line*) – Rozybakiev koshesi (*the NEW PROPOSED STATION, the Interchange node with the Proposed Radial GREY Line*) – Sairan (*the Interchange node with the Planned Radial Line*) – Moskwa (*the Interchange node with the Planned Radial Line*).

THE 1st PLANNED RADIAL LINE – the Continuation of the Existing Line (9 stations, 6 interchange nodes): Raiymbek Batyr (*the Station of the Existing Line, the Interchange node with the Proposed Radial BLUE Line*) – Seifullin dangly (*the Interchange node with the Proposed Radial YELLOW Line*) – Kotchin koshesi (*the Interchange node with the Proposed Radial ORANGE Line*) – Baumny Togaiy – Zhumabaev koshesi (*the Interchange node with the Proposed Radial GREEN Line*) – Tschernevsky koshesi – Wokzal Almaty-1 (*the NEW PROPOSED STATION, the Interchange node with the Proposed Ring RED Line*) – Bekmakhanov koshesi – Beisembaev koshesi (*the Interchange node with the Proposed Radial CELADON Line*) – Yntymak (*the Interchange node with the Planned Radial Line*).

THE 2nd PLANNED RADIAL LINE – the Continuation of the Constructed Line (4 stations, 1 interchange node): Moskwa (*the Station of the Constructed Line*) – Saryarka – Zhetysu (*the NEW PROPOSED STATION, the Interchange node with the Proposed Ring RED Line*) – Dostyk – Kalkaman.

THE 3rd PLANNED RADIAL LINE (15 stations, 10 interchange node): Orbita (*the Interchange node with the Proposed Ring RED Line*) – Khodjanov koshesi – Zhandosov koshesi (*the Interchange node with the Proposed Radial GREEN Line*) – Sairan (*the Interchange node with the Constructed Radial Line*) – Tastak (*the NEW PROPOSED STATION, the Interchange node with the Proposed Radial BLUE Line*) – Tole Bi koshesi (*the Interchange node with the Planned Line / the Proposed Radial GREY Line*) – Aitiyev koshesi (*the Interchange node with the Proposed Radial BROWN Line*) – Muratbaev koshesi (*the Interchange node with the Proposed Radial GREEN Line*) – Gogol' koshesi (*the Interchange node with the Proposed Radial YELLOW Line*) – Zhibek Zholy (*the Interchange node with the Existing Line*) – Kok Bazar (*the NEW PROPOSED STATION, the Interchange node with the Proposed Radial CELADON Line*) – Baribaev koshesi – Ormanov koshesi (*the NEW PROPOSED STATION*) – Orenburg koshesi – Duman (*the Interchange node with the Proposed Ring RED Line*).

THE 4th PLANNED LINE (9 stations, 7 interchange node): Tole Bi koshesi (*the Interchange node with the Planned Radial Line*) – Kuderin koshesi (*the Interchange node with the Proposed Radial BLUE Line*) – Severnoe Koltso koshesi (*the Interchange node with the Proposed Radial ORANGE Line*) – Zaria Wostoka (*the NEW PROPOSED STATION, the Interchange node with the Proposed Radial BROWN Line*) – Dorozhnik (*the Interchange node with the Proposed Radial YELLOW Line*) – Tscheriomushki (*the Interchange node with the Proposed Ring RED Line*) – Karasu – Pervomaisky – Esentai (*the Interchange*

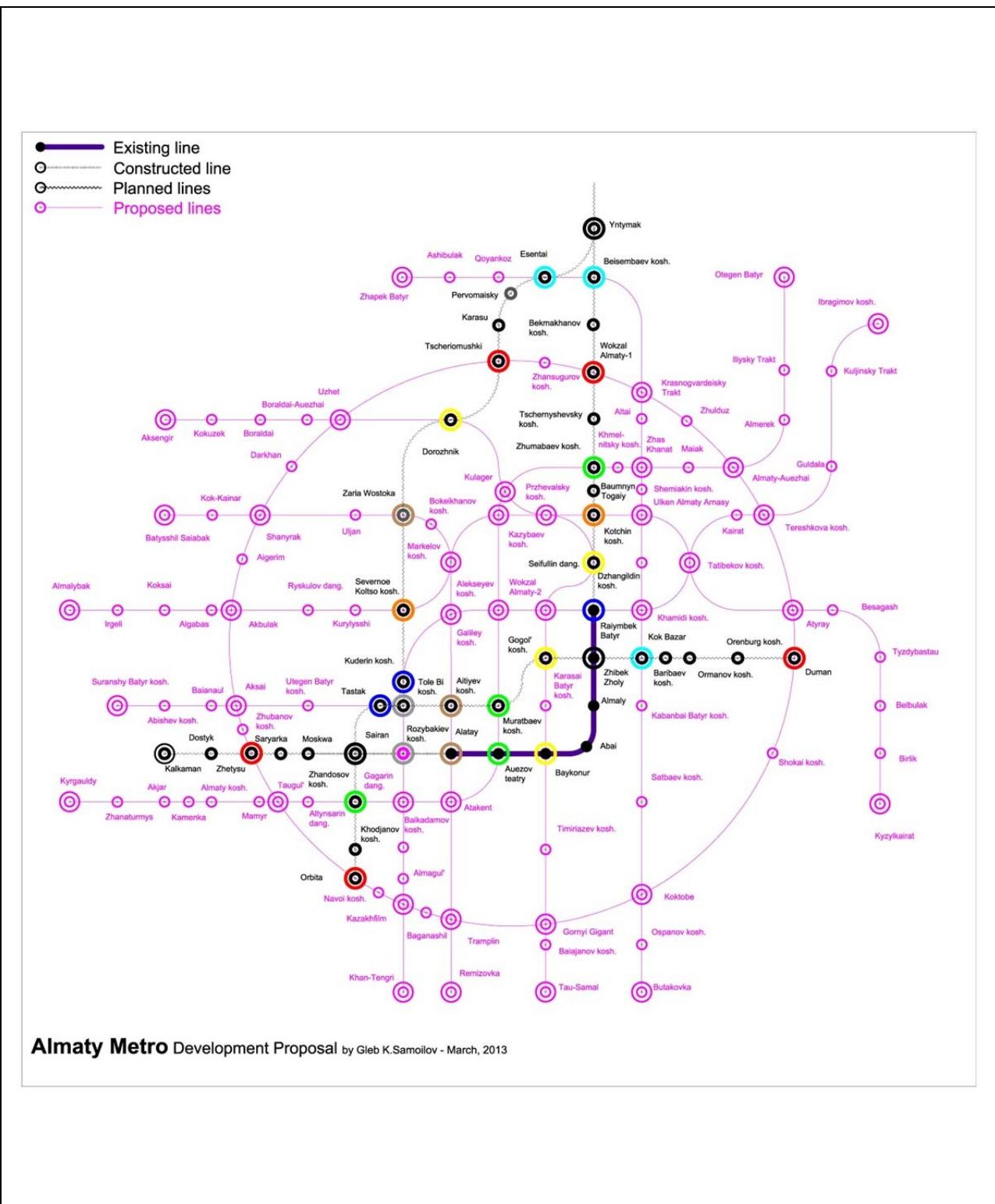


Figure 9.
Positions of existing, constructed and planned lines
in the proposed Radial-Ring network of the Almaty Metro.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

node with the Proposed Radial CELADON Line) – Yntymak (the Interchange node with the Planned Radial Line).

Positions of existing, constructed and planned lines in the proposed Radial-Ring network of the Almaty Metro are shown in the Figure 9.

The 1st proposed line (Ring) in the diagram is shown in Red. The stations of this line provide interchanges to all the radial lines (planned and proposed: Yellow, Blue, Green, Orange, Brown, Grey, Celadon). **THE PROPOSED RING RED LINE** (26 stations, 18 interchange nodes): *Almaty-Auezhai (the Interchange node with the Proposed Radial GREEN Line) – Tereshkova koshesi (the Interchange node with the Proposed Radial BLUE Line) – Atyray (the Interchange node with the Proposed Radial ORANGE Line) – Duman (the Interchange node with the Planned Radial Line) – Shokai koshesi – Koktobe (the Interchange node with the Proposed Radial CELADON Line) – Gornyi Gigant (the Interchange node with the Proposed Radial YELLOW Line) – Tramplin (the Interchange node with the Proposed Radial BROWN Line) – Baganashil – Kazakhfilm (the Interchange node with the Proposed Radial GREY Line) – Navoi koshesi – Orbita (the Interchange node with the Planned Radial line) – Taugul' (the Interchange node with the Proposed Radial GREEN Line) – Zhetsu (the Interchange node with the Planned Radial Line) – Zhubanov koshesi – Aksai (the Interchange node with the Proposed Radial BLUE Line) – Akbulak (the Interchange node with the Proposed Radial ORANGE Line) – Aigerim – Shanyrak (the Interchange node with the Proposed Radial BROWN Line) – Darkhan – Uzhet (the Interchange node with the Proposed Radial YELLOW Line) – Tscheriomushki (the Interchange node with the Planned Radial Line) – Zhansugurov koshesi – Wokzal Almaty-1 (the Interchange node with the Planned Radial Line) – Krasnogvardeisky Trakt (the Interchange node with the Proposed Radial CELADON Line) – Zhulduz*.

The position of the proposed Ring Red line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 10.

The 2nd proposed line (Radial) in the diagram is shown in Green. The stations of this line provide interchanges to the ring line and radial lines (existing, planned and proposed: Red, Blue, Yellow, Orange, Brown, Grey and Celadon). **THE PROPOSED RADIAL GREEN LINE** (24 stations, 12 interchange nodes): Kyrgauldy – Zhanaturmys – Akjar – Kamenka – Almaty koshesi – Mamyr – Taugul' (the Interchange node with the Proposed Ring RED Line) – Altynsarın dangly – Zhandosov koshesi (the Interchange node with the Planned Radial Line) – Gagarin dangly (the Interchange node with the Proposed Radial GREY Line) – Atakent (the Interchange node with the Proposed Radial BROWN Line) – Auezov Teatry (the Interchange node with the Existing Line) – Muratbaev koshesi (the Interchange node with the Planned Radial Line) – Alekseev koshesi (the Interchange node with the Proposed Radial BLUE Line) – Kazybaev koshesi (the Interchange node with the Proposed Radial ORANGE Line) – Kulager (the Interchange node with the Proposed Radial YELLOW Line) – Zhumabaev koshesi (the Interchange node with the Planned Radial Line) – Khmelknitsky koshesi – Zhas Kanat (the Interchange node with the Proposed Radial CELADON Line) – Maiak – Almaty Auezhai (the Interchange node with the Proposed Ring RED Line) – Almerek – Ilysky Trakt – Otegen Batyr.

The position of the proposed Radial Green line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 11.

The 3rd proposed line (Radial) in the diagram is shown in Blue. The stations of this line provide interchanges to the ring line and radial lines (existing, planned and proposed: Red, Yellow, Green, Orange, Brown and Celadon). **THE PROPOSED RADIAL BLUE LINE** (18 stations, 10 interchange nodes): Suranshy Batyr koshesi – Abishev koshesi – Baianaul – Aksai (the Interchange node with the Proposed Ring RED Line) – Utegen Batyr koshesi – Tastak (the Interchange node with the Planned Radial Line) – Kuderin koshesi (the Interchange node with the Planned Radial Line) – Galiley koshesi (the Interchange node with the Proposed Radial BROWN Line) – Alekseyev koshesi (the Interchange node with the Proposed Radial GREEN Line) – Wokzal Almaty-2 (the Interchange node with the Proposed Radial YELLOW Line) – Raiymbek Batyr (the Interchange node with the Existing Line / Planned Radial Line) – Khamidi koshesi (the Interchange node with the Proposed Radial CELADON Line) – Tatibekov koshesi (the

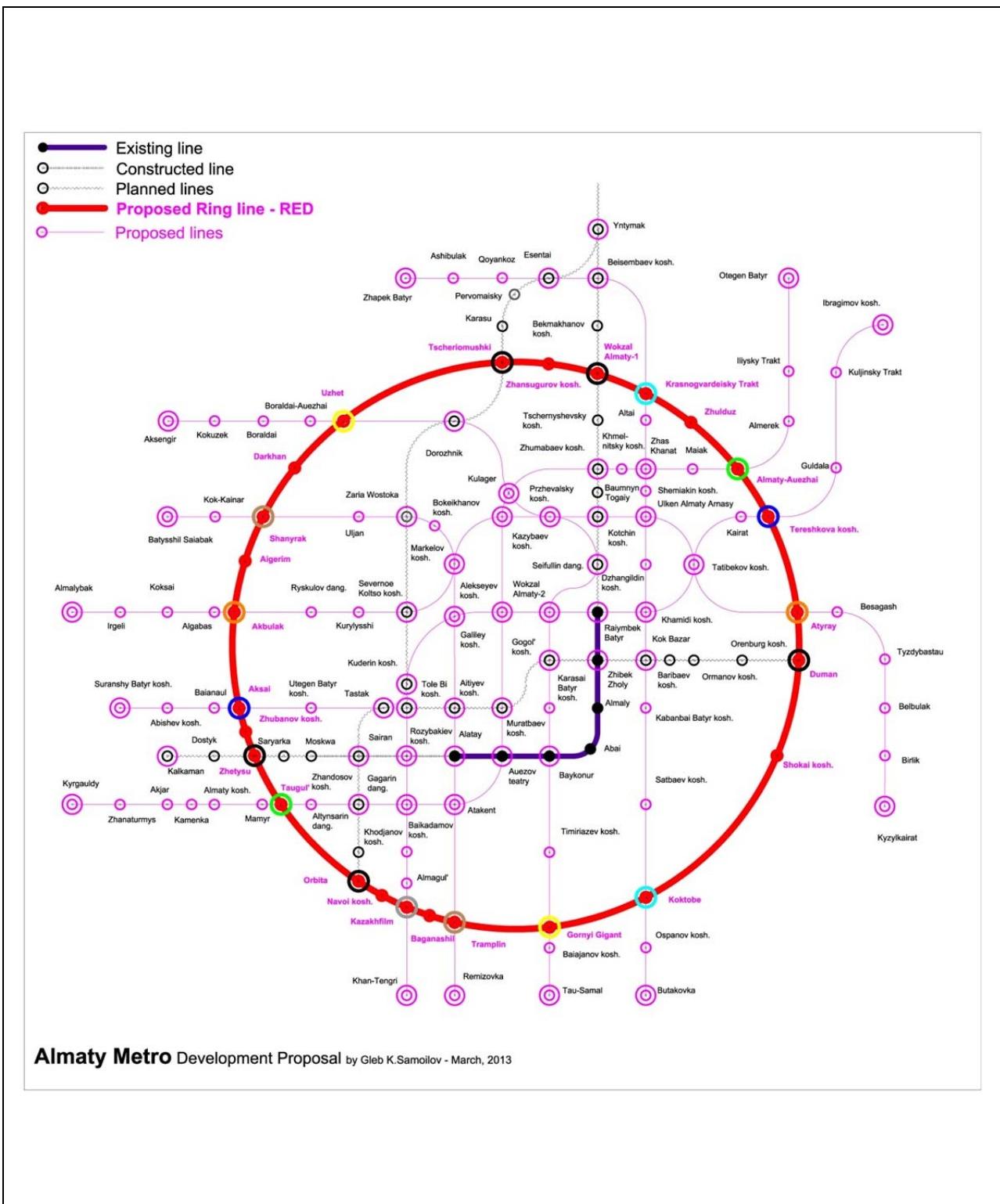


Figure 10.
 The position of the proposed Ring Red line
 in the proposed Radial-Ring network of the Almaty Metro.

Images source:

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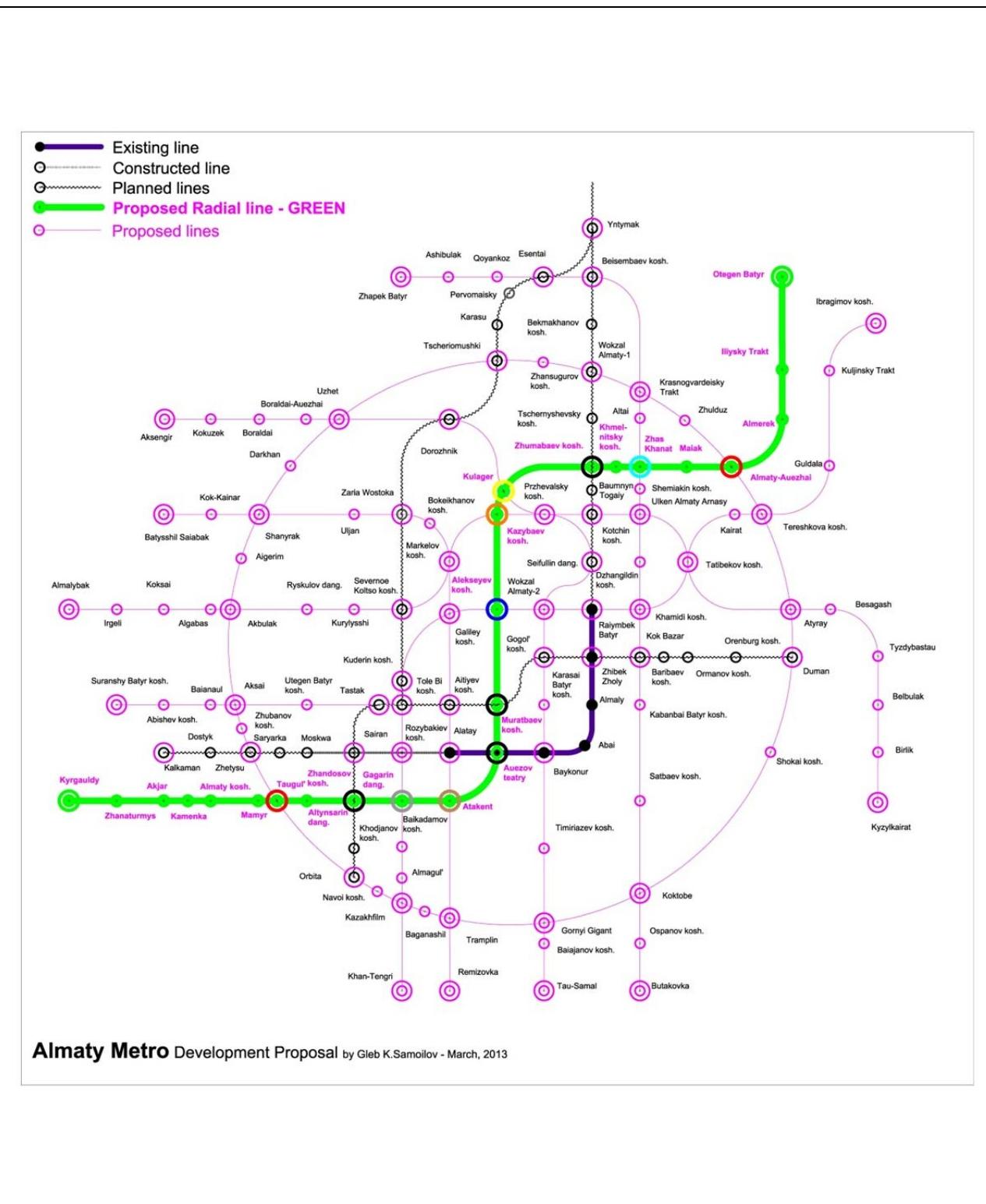


Figure 11.
The position of the proposed Radial Green line
in the proposed Radial-Ring network of the Almaty Metro.

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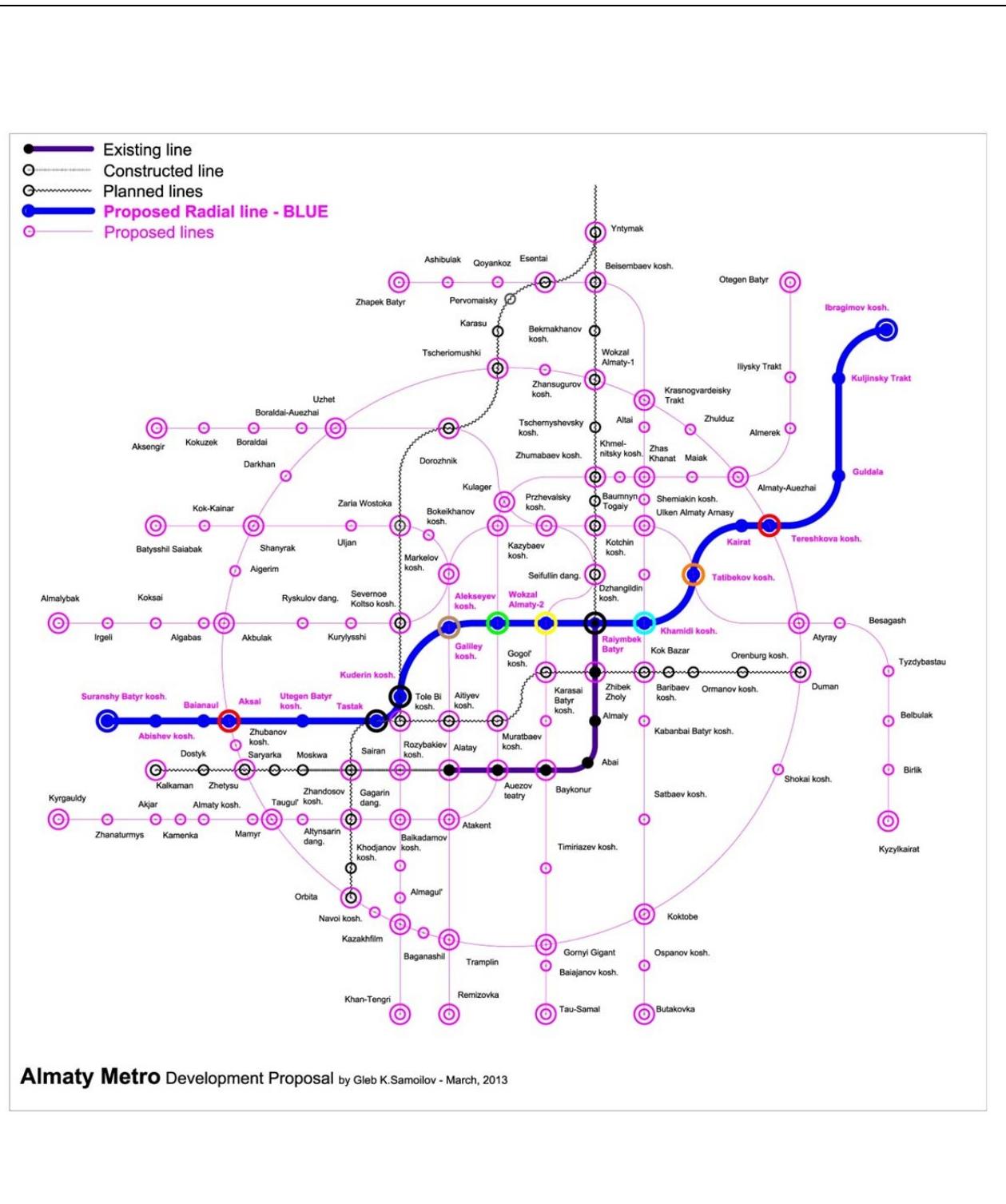


Figure 12.
The position of the proposed Radial Blue line
in the proposed Radial-Ring network of the Almaty Metro.
Images source:

Ring network
Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K Samoilov (2013)

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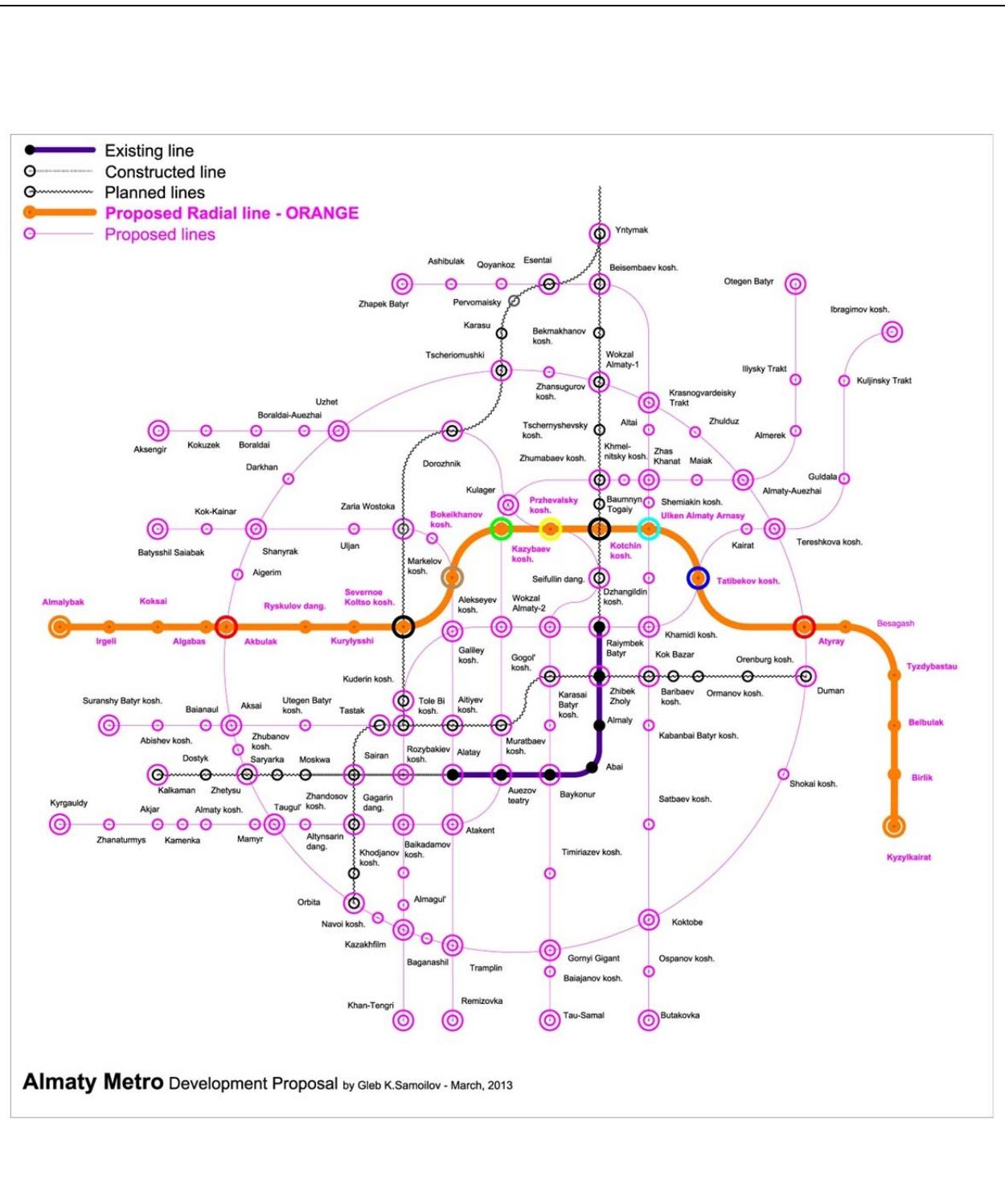


Figure 13.
The position of the proposed Radial Orange line
in the proposed Radial-Ring network of the Almaty Metro.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

Interchange node with the Proposed Radial ORANGE Line) – Kairat – Tereshkova koshesi (the Interchange node with the Proposed Ring RED Line) – Guldala – Kuljinsky Trakt – Ibragimov koshesi.

The position of the proposed Radial Blue line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 12.

The 4th proposed line (Radial) in the diagram is shown in Orange. The stations of this line provide interchanges to the ring line and radial lines (planned and proposed: Red, Blue, Green, Yellow, Brown and Celadon). **THE PROPOSED RADIAL ORANGE LINE** (20 stations, 9 interchange nodes): Almalybak – Irgeli – Koksai – Algabas – Akbulak (*the Interchange node with the Proposed Ring RED Line*) – Ryskulov dangly – Kurylysshi – Severnoe Koltso koshesi (*the Interchange node with the Planned Radial Line*) – Bokeikhanov koshesi (*the Interchange node with the Proposed Radial BROWN Line*) – Kazybaev koshesi (*the Interchange node with the Proposed Radial GREEN Line*) – Przhevalsky koshesi (*the Interchange node with the Proposed Radial YELLOW Line*) – Kotchin koshesi (*the Interchange node with the Planned Radial Line*) – Ulken Almaty Arnasy (*the Interchange node with the Proposed Radial CELADON Line*) – Tatibekov koshesi (*the Interchange node with the Proposed Radial BLUE Line*) – Atyray (*the Interchange node with the Proposed Ring RED Line*) – Besagash – Tyzdybastau – Belbulak – Birlik – Kyzylkairat.

The position of the proposed Radial Orange line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 13.

The 5th proposed line (Radial) in the diagram is shown in Brown. The stations of this line provide interchanges to the ring line and radial lines (existing, planned and proposed: Red, Blue, Green, Orange). **THE PROPOSED RADIAL BROWN LINE** (13 stations, 8 interchange nodes): Batysshil Saiabak – Kok-Kainar – Shanyrak (*the Interchange node with the Proposed Ring RED Line*) – Uljan – Zaria Wostoka (*the Interchange node with the Planned Radial Line*) – Markelov koshesi – Bokeikhanov koshesi (*the Interchange node with the Proposed Radial ORANGE Line*) – Galiley koshesi (*the Interchange node with the Proposed Radial BLUE Line*) – Aitiyev koshesi (*the Interchange node with the Planned Radial Line*) – Alatay (*the Interchange node with the Existing Line*) – Atakent (*the Interchange node with the Proposed Radial GREEN Line*) – Tramplin (*the Interchange node with the Proposed Ring RED Line*) – Remizovka.

The position of the proposed Radial Brown line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 14.

The 6th proposed line (Radial) in the diagram is shown in Yellow. The stations of this line provide interchanges to the ring line and radial lines (existing, planned and proposed: Red, Blue, Green and Orange). **THE PROPOSED RADIAL YELLOW LINE** (17 stations, 9 interchange nodes): Aksengir – Kokuzek – Boraldai – Boral dai-Auezhai – Uzhet (*the Interchange node with the Proposed Ring RED Line*) – Dorozhnik (*the Interchange node with the Planned Radial Line*) – Kulager (*the Interchange node with the Proposed Radial GREEN Line*) – Przhevalsky koshesi (*the Interchange node with the Proposed Radial ORANGE Line*) – Seifullin dangly (*the Interchange node with the Planned Radial Line*) – Wokzal Almaty-2 (*the Interchange node with the Proposed Radial BLUE Line*) – Gogol' koshesi (*the Interchange node with the Planned Radial Line*) – Karasai Batyr koshesi – Baykonur (*the Interchange node with the Existing Line*) – Timiriazev koshesi – Gorny Gigant (*the Interchange node with the Proposed Ring RED Line*) – Baiajanov koshesi – Tau-Samal.

The position of the proposed Radial Yellow line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 15.

The 7th proposed line (Radial) in the diagram is shown in Celadon. The stations of this line provide interchanges to the ring line and radial lines (planned and proposed: Red, Blue, Green, Orange). **THE PROPOSED RADIAL CELADON LINE** (18 stations, 8 interchange nodes): Zhapek Batyr – Ashibulak – Qoyankoz – Esentai (*the Interchange node with the Planned Radial Line*) – Beisembaev koshesi (*the Interchange node with the Planned Radial Line*) – Krasnogvardeisky Trakt (*the Interchange node with the Proposed Ring RED Line*) – Altai – Zhas Kanat (*the Interchange node with the Proposed GREEN Line*) – Shemiakin koshesi – Ulken Almaty Arnasy (*the Interchange node with the Proposed Radial ORANGE Line*) – Dzhangildin koshesi – Khamidi koshesi (*the Interchange node with the Proposed Radial BLUE Line*) – Kok Bazar (*the Interchange node with the Planned Radial Line*) – Kabanbai Batyr koshesi –

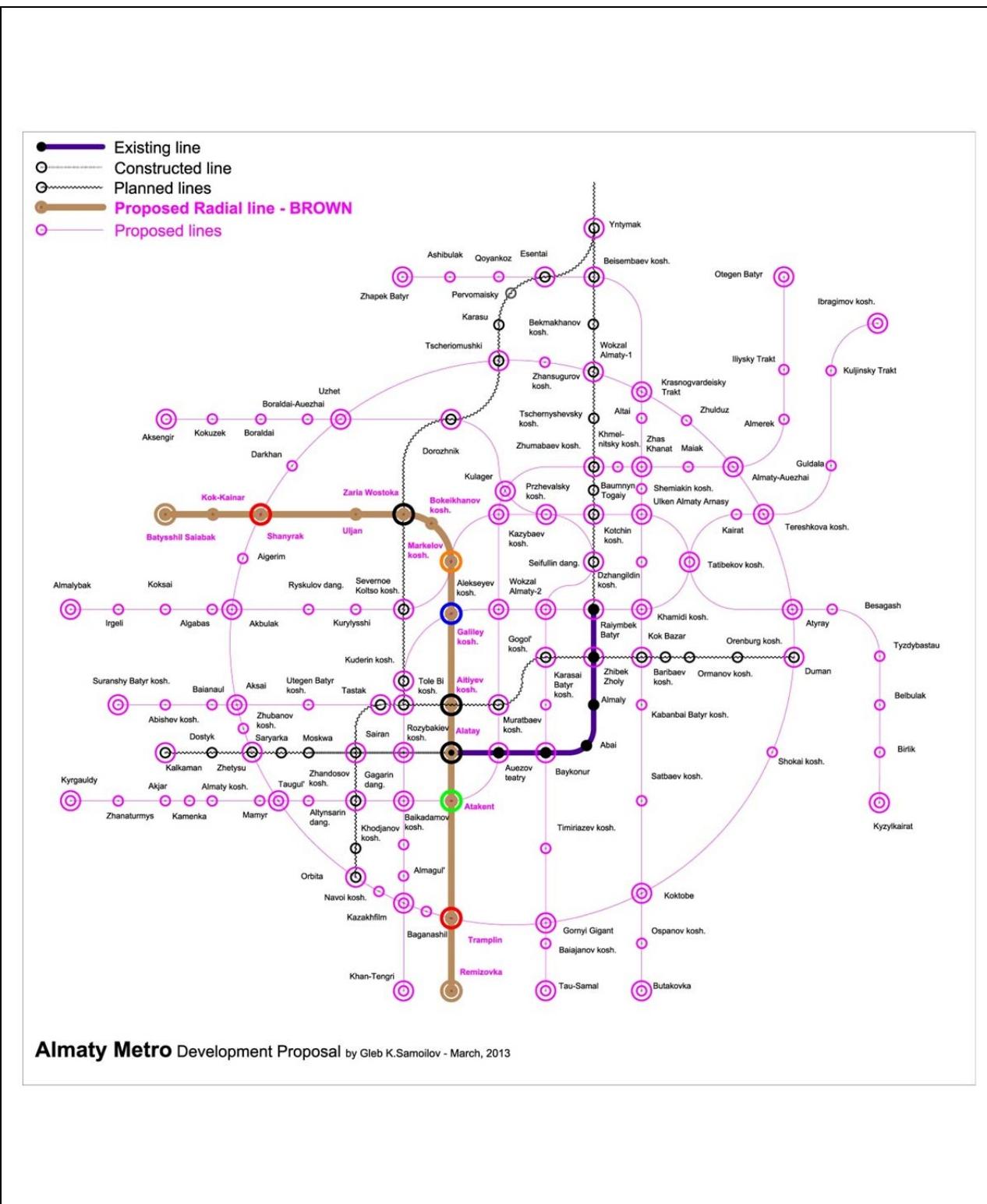


Figure 14.
 The position of the proposed Radial Brown line
 in the proposed Radial-Ring network of the Almaty Metro.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

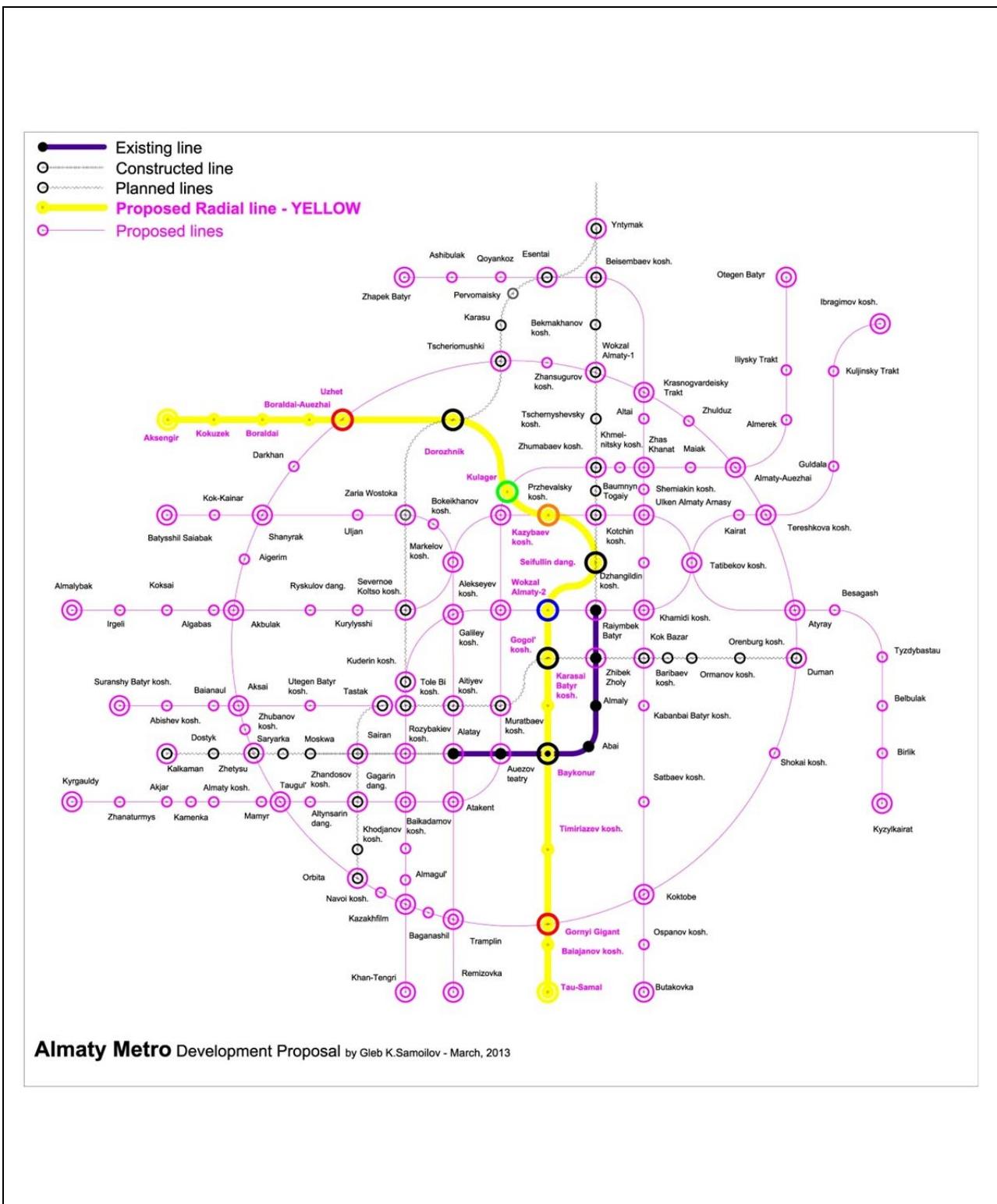


Figure 15.
 The position of the proposed Radial Yellow line
 in the proposed Radial-Ring network of the Almaty Metro.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

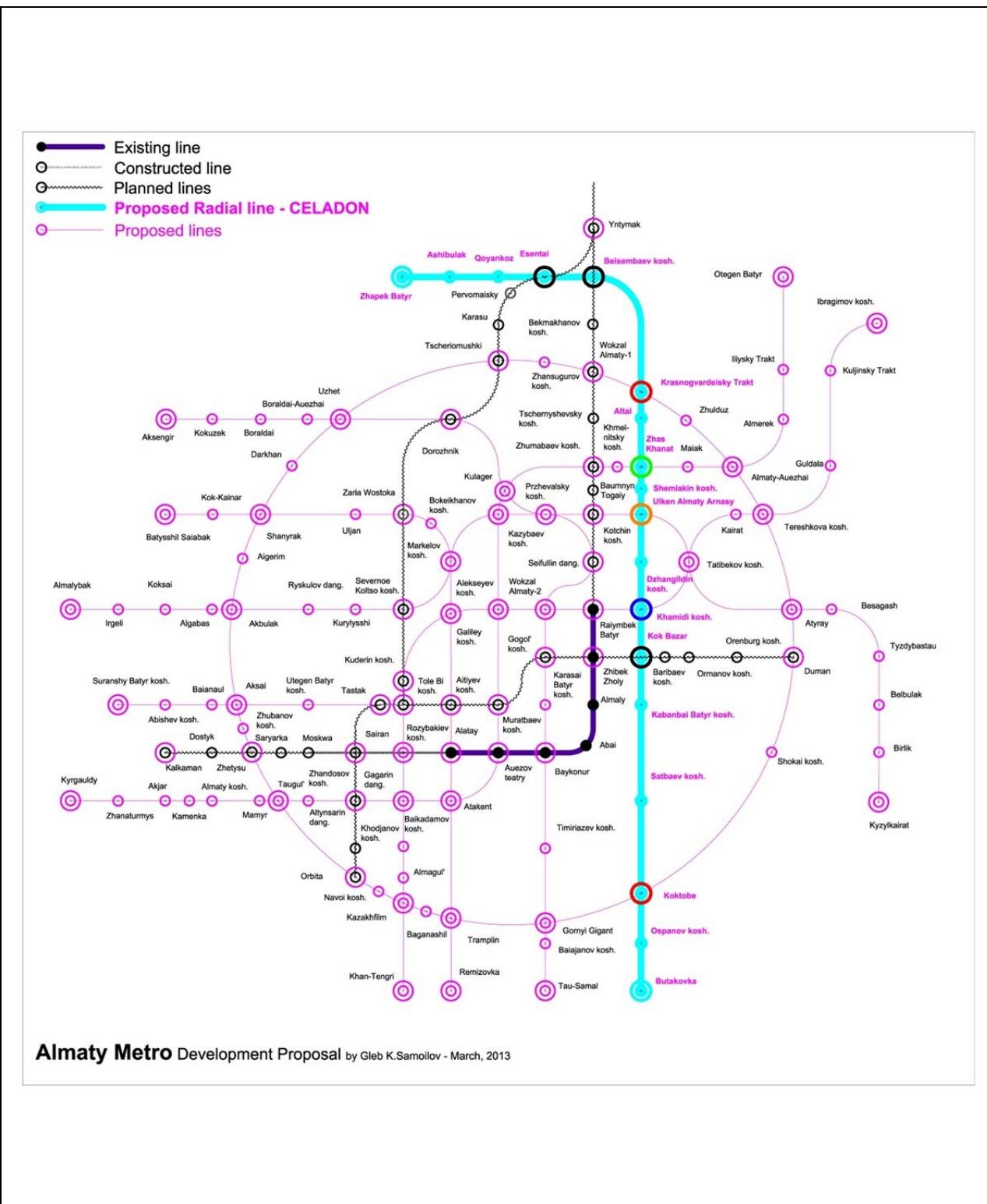


Figure 16.
The position of the proposed Radial Celadon line
in the proposed Radial-Ring network of the Almaty Metro.

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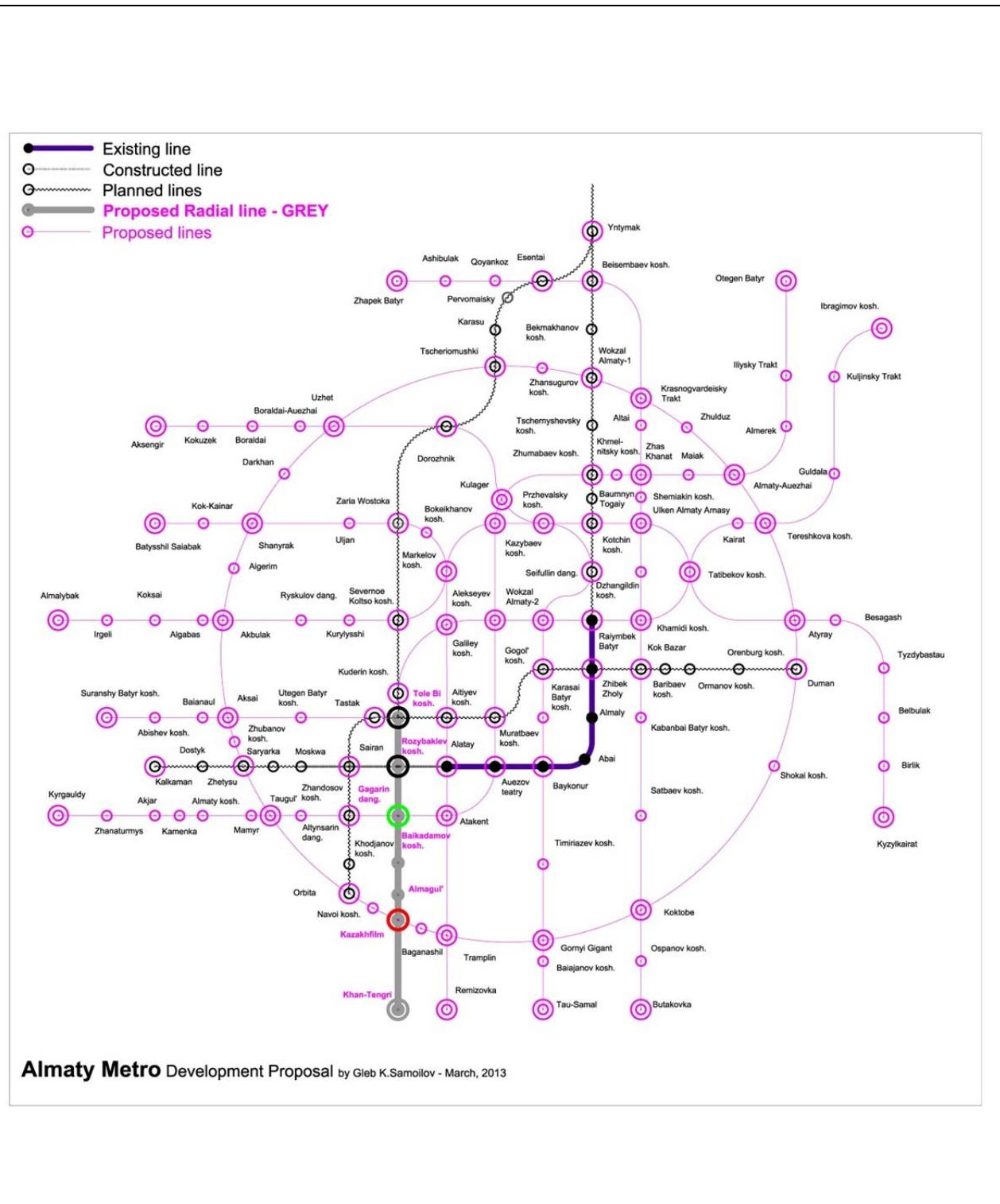


Figure 17.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

Satbaev koshesi – Koktobe (*the Interchange node with the Proposed Ring RED Line*) – Ospanov koshesi – Butakovka.

The position of the proposed Radial Celadon line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 16.

The 8th proposed line (Radial) in the diagram is shown in Grey. The stations of this line provide interchanges to the ring line and radial lines (constructed, planned and proposed: Red, Green). THE PROPOSED RADIAL GREY LINE (7 stations, 4 interchange nodes): Tole Bi koshesi (*the Interchange node with the Planned Radial Line*) – Rozybakiev koshesi (*the Interchange node with the Constructed Line*) – Gagarin dangly (*the Interchange node with the Proposed Radial GREEN Line*) – Baikadamov koshesi – Almagul' – Kazakhfilm (*the Interchange node with the Proposed Ring RED Line*) – Khan-Tengri.

The position of the proposed Radial Grey line in the proposed Radial-Ring network of the Almaty Metro is shown in the Figure 17.

In proposed extensive Metro scheme the interchanges of two kinds are applied – "Parallel" and "Perpendicular". All the new stations have "Island" platform type. Reconstructed stations have platforms of "Island" type and "Coastal" type.

A "Parallel" interchange node provides the transfer on the station in two ways: "On the same platform" with the transfer of passengers in the forward direction, or "Over the platform" for transfer of passengers in the opposite direction. These are interchange nodes with the largest number of passengers (8 points):

YNTYMAK – the Interchange node between Planned Radial Lines;

ALMATY AUEZHAI – the Interchange node between the Proposed Radial GREEN Line and the Proposed Ring RED line;

SEIFULLIN DANDYLY – the Interchange node between the Planned Radial Line and the Proposed Radial YELLOW line;

TERESHKOVA KOSHESI – the Interchange node between the Proposed Radial BLUE Line and the Proposed Ring RED line;

TATIBEKOV KOSHESI – the Interchange node between the Proposed Radial BLUE Line and the Proposed Radial ORANGE line;

KUDERIN KOSHESI – the Interchange node between the Proposed Radial BLUE Line and the Planned Radial line;

TASTAK – the Interchange node between the Proposed Radial BLUE Line and the Planned Radial line;

BEISEMBAEV KOSHESI – the Interchange node between the Proposed Radial CELADON Line and the Planned Radial line.

A "Perpendicular" interchange node provides the passenger transition from the station to the station in three versions: "Side-Side", "Middle-Side" or "Side-Middle", "Middle-Middle" (47 points):

RAIYMBEK BATYR – the Interchange node between the Existing Line /the Planned Radial Line and with the Proposed Radial BLUE Line;

ZHIBEK ZHOLY – the Interchange node between the Existing Line and the Planned Radial Line;

BAYKONUR – the Interchange node between the Existing Line and Proposed Radial YELLOW Line;

AUEZOV TEATRY – the Interchange node between the Existing Line and the Proposed Radial GREEN Line;

ALATAY – the Interchange node between the Existing Line / the Constructed Line and the Proposed Radial BROWN Line;

ROZYBAKIEV KOSHESI – the Interchange node between the Constructed Line and the Proposed Radial GREY Line;

SAIRAN – the Interchange node between the Constructed Line and the Planned Radial Line;

KOTCHIN KOSHESI – the Interchange node between the Planned Line and the Proposed Radial ORANGE Line;

ZHUMABAEV KOSHESI – the Interchange node between the Planned Line and the Proposed Radial GREEN Line;

WOKZAL ALMATY-1 – the Interchange node between the Planned Line and the Proposed Ring RED Line;

ZHETYSU – the Interchange node between; the Planned Line and the Proposed Ring RED Line;

ORBITA – the Interchange node between the Planned Line and the Proposed Ring RED Line;

ZHANDOSOV KOSHESI – the Interchange node between the Planned Line and the Proposed Radial GREEN Line;

TOLE BI KOSHESI – the Interchange node between the Planned Line and the Planned Line / the Proposed Radial GREY Line;

AITIYEV KOSHESI – the Interchange node between the Planned Line and the Proposed Radial BROWN Line;

MURATBAEV KOSHESI – the Interchange node between the Planned Line and the Proposed Radial GREEN Line;

GOGOL' KOSHESI – the Interchange node between the Planned Line and the Proposed Radial YELLOW Line;

KOK BAZAR – the Interchange node between the Planned Line and the Proposed Radial CELADON Line;

DUMAN – the Interchange node between the Planned Line and the Proposed Ring RED Line;

SEVERNOE KOLTSO KOSHESI – the Interchange node between the Planned Line and the Proposed Radial ORANGE Line;

ZARIA WOSTOKA – the Interchange node between the Planned Line and the Proposed Radial BROWN Line;

DOROZHNIK – the Interchange node between the Planned Line and the Proposed Radial YELLOW Line;

TSCHERIOMUSHKI – the Interchange node between the Planned Line and the Proposed Ring RED Line;

ESENTAI – the Interchange node between the Planned Line and the Proposed Radial CELADON Line;

ATYRAY – the Interchange node between the Planned Line and the Proposed Ring RED Line;

KOKTOBE – the Interchange node between the Proposed Ring RED Line and the Proposed Radial CELADON Line;

GORNYI GIGANT – the Interchange node between the Proposed Ring RED Line and the Proposed Radial YELLOW Line;

TRAMPLIN – the Interchange node between the Proposed Ring RED Line and the Proposed Radial BROWN Line;

KAZAKHFILEM – the Interchange node between the Proposed Ring RED Line and the Proposed Radial GREY Line;

TAUGUL' – the Interchange node between the Proposed Ring RED Line and the Proposed Radial GREEN Line;

AKSAI – the Interchange node between the Proposed Ring RED Line and the Proposed Radial BLUE Line;

AKBULAK – the Interchange node between the Proposed Ring RED Line and the Proposed Radial ORANGE Line;

SHANYRAK – the Interchange node between the Proposed Ring RED Line and the Proposed Radial BROWN Line;

UZHET – the Interchange node between the Proposed Ring RED Line and the Proposed Radial YELLOW Line;

KRASNOGVARDEISKY TRAKT – the Interchange node between the Proposed Ring RED Line and the Proposed Radial CELADON Line;

GAGARIN DANGYLЫ – the Interchange node between the Proposed Radial GREEN Line and the Proposed Radial GREY Line;

ATAKENT – the Interchange node between the Proposed Radial GREEN Line and the Proposed Radial BROWN Line;

ALEKSEEV KOSHESI – the Interchange node between the Proposed Radial GREEN Line and the Proposed Radial BLUE Line;

KAZYBAEV KOSHESI – the Interchange node between the Proposed Radial GREEN Line and the Proposed Radial ORANGE Line;

KULAGER – the Interchange node between the Proposed Radial GREEN Line and the Proposed Radial YELLOW Line;

ZHAS KANAT – the Interchange node between the Proposed Radial GREEN Line and the Proposed Radial CELADON Line;

GALILEY KOSHESI – the Interchange node between the Proposed Radial BLUE Line and the Proposed Radial BROWN Line;

WOKZAL ALMATY-2 – the Interchange node between the Proposed Radial BLUE Line and the Proposed Radial YELLOW Line;

KHAMIDI KOSHESI – the Interchange node between the Proposed Radial BLUE Line and the Proposed Radial CELADON Line;

BOKEIKHANOV KOSHESI – the Interchange node between the Proposed Radial ORANGE Line and the Proposed Radial BROWN Line;

PRZHEVALSKY KOSHESI – the Interchange node between the Proposed Radial ORANGE Line and the Proposed Radial YELLOW Line;

ULKEN ALMATY ARNASY – the Interchange node between the Proposed Radial ORANGE Line and the Proposed Radial CELADON Line.

All new stations vestibules for inputs and outputs from streets (antechambers or anterooms) are located below ground. Each from six existing stations have only one vestibule. The Alatau station has two vestibules. Each new station has two vestibules. The Main vestibule has descent by escalator to the platform (4 escalators); the Second vestibule has descent by elevator to the platform (4 elevators). In some situations the Main vestibule of the Interchange node provides entrances/exits on both stations. This vestibule has 8 escalators – 4 escalators for each platform.

The Almaty Metro developed network lines, stations and station's Main vestibules locations are given in the Table 2.

Table 2.

The Almaty Metro developed network lines, stations and station's main vestibules locations

No/№	THE METRO STATION	<i>The Interchange node or the Ordinary station</i>	Proposed location of main underground vestibules for entrances/exits (approximately)
1	2	3	4
I	<i>The Existing RADIAL LINE</i>		
1	RAIYMBEK BATYR (existing)	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Raiymbek Avenue – angle of the Furmanov Street (existing)

2	ZHIBEK ZHOLY (existing)	<i>The Interchange node with the Planned Radial Line</i> 	The Gogol' Street – angle of the Panfilov Street (existing)
3	ALMALY (existing)	<i>The Ordinary station</i>	The Karasai Batyr Street – angle of the Panfilov Street (existing)
4	ABAI (existing)	<i>The Ordinary station</i>	The Abai Avenue – angle of the Tulebaev Street (existing)
5	BAYKONUR (existing)	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Abai Avenue – angle of the Baitursynov Street (existing)
6	AUEZOV TEATRY (existing)	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Abai Avenue – angle of the Musrepov Street (existing)
7	ALATAY (existing)	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Abai Avenue – angle of the Zharokov Street (existing)
<hr/>			
II	<i>The Constructed RADIAL LINE (the Continuation of the Existing Radial Line)</i>	 	
1	ALATAY (existing)	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Abai Avenue – angle of the Zharokov Street (existing)
2	ROZYBAKIEV KOSHESI (the new Proposed station)	<i>The Interchange node with the Proposed Radial GREY Line</i> 	The Abai Avenue – angle of the Rosybakiev Street
3	SAIRAN	<i>The Interchange node with the Planned Radial Line</i> 	The Tlendiev Street – angle of the Abai Avenue
4	MOSKWA	<i>The Ordinary station</i>	The Utegen Batyr Street – angle of the Abai Avenue
<hr/>			
III	<i>The 1st Planned RADIAL LINE (the Continuation of the Existing Radial Line)</i>	 	
1	RAIYMBEK BATYR (existing)	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Raiymbek Avenue – angle of the Furmanov Street (existing)

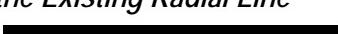
2	SEIFULLIN DANGLYLY	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Seifullin Avenue – angle of the Zhansugurov Street
3	KOTCHIN KOSHESI	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Kotchin Street – angle of the Ryskulov Avenue
4	BAUMNYN TOGAIY	<i>The Ordinary station</i>	The Akan Sery Street (near the Baum's Grove)
5	ZHUMABAEV KOSHESI	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Zhumabaev Street – angle of the Seifullin Avenue
6	TSCHERNY-SHEVSKY KOSHESI	<i>The Ordinary station</i>	The Tschernyshevsky Street – angle of the Seifullin Avenue
7	WOKZAL ALMATY-1 (the new Proposed station)	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Seifullin Avenue (near the "Almaty-1st" Railway Station)
8	BEKMAKHA-NOV KOSHESI	<i>The Ordinary station</i>	The Bekmakhanov Street – angle of the Bartol'd Street
9	BEISEMBAEV KOSHESI	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Beisembaev Street – angle of the Onejskaia Street
10	YNTYMAK	<i>The Interchange node with the Planned Radial Line</i> 	The Yntymak Zhana Daur zholy Street – angle of the Zhansugurov Street (near the High-speed Railway Station)
IV	<i>The 2nd Planned RADIAL LINE</i> (the Continuation of the Constructed Radial Line)		
1	MOSKWA	<i>The Ordinary station</i>	The Utegen Batyr Street – angle of the Abai Avenue
2	SARYARKA	<i>The Ordinary station</i>	The lantarnaia Street – angle of the Abai Avenue
3	ZHETYSU (the new Proposed station)	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Sain Street – angle of the Abai Avenue (the Zhetysu Micro District)
4	DOSTYK	<i>The Ordinary station</i>	The Momyshuly Street – angle of the Abai Avenue
5	KALKAMAN	<i>The Ordinary station</i>	The Zhuldyz Street – Angle of the Zhaili Street
V	<i>The 3rd Planned</i>		

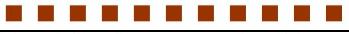
	<i>RADIAL LINE</i>		
1	ORBITA	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Birzhan Street – angle of the Al-Farabi Avenue
2	KHODJANOV KOSHESI	<i>The Ordinary station</i>	The Khodjanov Street – angle of the Tazhibaeva Street
3	ZHANDOSOV KOSHESI	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Zhandosov Street – Angle of the Timiriazev Street
4	SAIRAN	<i>The Interchange node with the Constructed Radial Line</i> 	The Tlendiev Street – angle of the Abai Avenue
5	TASTAK (the new Proposed station)	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Tole Bi Street – Angle of the Turkebaev Street
6	TOLE BI KOSHESI	<i>The Interchange node with the Planned Radial Line</i>  <i>the Interchange node with the Proposed Radial GREY Line</i> 	The Tole Bi Street – angle of the Rozubakiev Street
7	AITIYEV KOSHESI	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Aitiyev Street – angle of the Tole Bi Street
8	MURATBAEV KOSHESI	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Muratbaev Street – Angle of the Tole Bi Street
9	GOGOL' KOSHESI	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Gogol' Street – angle of the Nauryzbai Batyr Street
10	ZHIBEK ZHOLY	<i>The Interchange node with the Existing Radial Line</i> 	Gogol' Street – angle of Panfilov Street
11	KOK BAZAR (the new Proposed station)	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Gogol' Street – angle of the Zenkov Street
12	BARIBAEV KOSHESI	<i>The Ordinary station</i>	The Baribaev Street – Angle of the Gogol' Street
13	ORMANOV KOSHESI (the new Proposed station)	<i>The Ordinary station</i>	The Ormanov Street – Angle of the Esenberlin Street
14	ORENBURG KOSHESI	<i>The Ordinary station</i>	The Orenburg Street – angle of the Shukhov Street
15	DUMAN	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Khatengri Street – angle of the Esil Street (the Duman Micro District)

VI	<i>The 4th Planned RADIAL LINE</i>	 	
1	TOLE BI KOSHESI	<i>The Interchange node with the Planned Radial Line</i>  <i>the Interchange node with the Proposed Radial GREY Line</i> 	The Tole Bi Street – angle of the Rozubakiev Street
2	KUDERIN KOSHESI	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Kuderin Street – Angle of the Borzov Street
3	SEVERNNE KOLTSO KOSHESI	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Ryskulov Avenue – angle of the Severnoe Koltso Street
4	ZARIA WOSTOKA (the new Proposed station)	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Severnoe Koltso Street – angle of the Gvardeiskaia Street
5	DOROZHNIK	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Severnoe Koltso Street – angle of the Bokeikhanov Street
6	TSCHERIO- MUSHKI	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Severnoe Koltso Street – angle of the Zhumabaeva Street
7	KARASU	<i>The Ordinary station</i>	The Severnoe Koltso Street – angle of the Burundaiskaia Street (the Karasu Micro district – near the Highway intersection)
8	PERVOMAISKY	<i>The Ordinary station</i>	The Zhambyl Street (the Pervomaisky village)
9	ESENTAI	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Zhansugurov Street (near the Esentai bridge)
10	YNTYMAK	<i>The Interchange node with the Planned Radial Line</i> 	The Yntymak Zhana Daur zholy Street – angle of the Zhansugurov Street (near the High-speed Railway Station)
VII	<i>The Proposed RING RED LINE</i>		
1	ALMATY- AUEZHAI	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Mailin Street – angle of the Akhmetov Street (near the Almaty Airport)
2	TERESHKOVA KOSHESI	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Bukhtarminskaia Street – angle of the Tereshkova Street

3	ATYRAY	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Kuljinsky Trakt – angle of the Ryskulov Avenue (the Atyrau Micro District)
4	DUMAN	<i>The Interchange node with the Planned Radial Line</i> 	The Khantengri Street – angle of the Esil Street (the Duman Micro District)
5	SHOKAI KOSHESI	<i>The Ordinary station</i>	The Shokai Street – angle of the Penzenskaia Street
6	KOKTOBE	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Omarova Street (near the "Europolis-Promenade Complex")
7	GORSKIY GIGANT	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Zhukov Street – angle of the Akhmediarov Street
8	TRAMPLIN	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Zhamakaev Street (near the Ski-jump Centre)
9	BAGANASHIL	<i>The Ordinary station</i>	The Syrgabecov Street – angle of the Grushovaia Street (the Baganashil Micro District)
10	KAZAKHFILEM	<i>The Interchange node with the Proposed Radial GREY Line</i> 	The Isinaliev Street – angle of the Arychnaia Street (the Kazakhfilm Micro District)
11	NAVOI KOSHESI	<i>The Ordinary station</i>	The Navoi Street – angle of the Al-Farabi Avenue (near the Park named after the Republic of Kazakhstan First President)
12	ORBITA	<i>The Interchange node with the Planned Radial Line</i> 	The Birzhan Street – angle of the Al-Farabi Avenue
13	TAUGUL'	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Zhandosov Street – angle of the Sain Street (the Taugul' Micro District)
14	ZHETYSU	<i>The Interchange node with the Planned Radial Line</i> 	The Sain Street – angle of the Abai Avenue (the Zhetysu Micro District)
15	ZHUBANOV KOSHESI	<i>The Ordinary station</i>	The Zhubanov Street – angle of the Abai Avenue
16	AKSAI	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Tole Bi Street – angle of the Sain Street (the Aksai Micro District)
17	AKBULAK	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Ryskulov Avenue – angle of the Zhumabekov Street (the Akbulak Micro District)
18	AIGERIM	<i>The Ordinary station</i>	The Zhana Gasyr Street – angle of the Makataev Street (the Aigerim Micro District)
19	SHANYRAK	<i>The Interchange node with the Proposed Radial BROWN Line</i>	The Alpamys Street – angle of the Akyn Sara Street

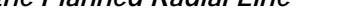
			(the Shanyrak Micro District)
20	DARKHAN	<i>The Ordinary station</i>	The Akhmetov Street – angle of the Altai Street (the Darkhan Micro District)
21	UZHET	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Ukelei Ybrai Street – angle of the Seitov Street
22	TSCHERIO-MUSHKI	<i>The Interchange node with the Planned Radial Line</i> 	The Severnoe Koltso Street – angle of the Zhumabaeva Street
23	ZHANSUGU-ROV KOSHESI	<i>The Ordinary station</i>	The Zhansugurov Street – Angle of the Pomialovsky Street
24	WOKZAL ALMATY-1	<i>The Interchange node with the Planned Radial Line</i> 	The Seifullin Avenue (near the "Almaty-1st" Railway Station)
25	KRASNO-GVARDEISKY TRAKT	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Suiunbai Avenue (near the "Detsky sad" Bus stop)
26	ZHULDUZ	<i>The Ordinary station</i>	The Dunentaev Street – angle of the Sobolev Street (the Zhulduz Micro District)
VIII	<i>The Proposed RADIAL GREEN LINE</i>		
1	KYRGAUPLY	<i>The Ordinary station</i>	Near the Multilevel Highway intersection (the Kyrgauldy village)
2	ZHANATURMYS	<i>The Ordinary station</i>	The Baiseitova Street – angle of the Ashimbaeva Street (the Zhanaturmys village)
3	AKJAR	<i>The Ordinary station</i>	The Zhandosov Street – angle of the Bekeshev Street (the Aklar village)
4	KAMENKA	<i>The Ordinary station</i>	The Beseuov Street – angle of the Zhandosov Street (the Kamenka village)
5	ALMATY KOSHESI	<i>The Ordinary station</i>	The Almatinskaia Street – angle of the Aibolit-2 Street
6	MAMYR	<i>The Ordinary station</i>	The Zhandosov Street – angle of the lassau Street (the Mamyr Micro District)
7	TAUGUL'	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Zhandosov Street – angle of the Sain Street (the Taugul' Micro District)
8	ALTYSARIN DANGLY	<i>The Ordinary station</i>	The Altysarin Avenue – Angle of the Zhandosov Street
9	ZHANDOSOV	<i>The Interchange node with</i>	The Zhandosov Street –

	KOSHESI	<i>the Planned Radial Line</i> 	Angle of the Timiriazev Street
10	GAGARIN DANGYLY	<i>The Interchange node with the Proposed Radial GREY Line</i> 	The Gagarin Avenue – Angle of the Timiriazev Street
11	ATAKENT	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Auezov Street – angle of the Timiriazev Street
12	AUEZOV TEATRY	<i>The Interchange node with the Existing Radial Line</i> 	The Abai Avenue – angle of the Musrepov Street
13	MURATBAEV KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Muratbaev Street – angle of the Tole Bi Street
14	ALEKSEEV KOSHESI	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Alekseev Street – angle of the Raiymbek Avenue
15	KAZYBAEV KOSHESI	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Kazybaev Street – Angle of the Ryskulov Avenue
16	KULAGER	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Kazybaev Street – angle of the Serikov Street (the Kulager Micro District)
17	ZHUMABAEV KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Zhumabaev Street – angle of the Seifullin Avenue
18	KHMELNITSKY KOSHESI	<i>The Ordinary station</i>	The Khmelnitsky Street – Angle of the Suiunbai Avenue
19	ZHAS KANAT	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Fedoseev Street – angle of the Shemiakin Street (the Zhas Kanat Micro District)
20	MAIAK	<i>The Ordinary station</i>	The Mukatai Street – angle of the Topchiev Street (the Maiak Micro District)
21	ALMATY AUEZHAI	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Mailin Street – angle of the Akhmetov Street (near the Almaty Airport)
22	ALMEREK	<i>The Ordinary station</i>	The Abai Street – angle of the Satbaev Street (the Almerek village)
23	ILISKY TRAKT	<i>The Ordinary station</i>	The Almatinskaia Street – angle of the Kataev Street (the Pokrovka village)
24	OTEGEN BATYR	<i>The Ordinary station</i>	The Aubakirov Street – angle of the Zhansugurov Street (Near the Multilevel Highway intersection – the Otegen Batyr village)
IX	<i>The Proposed</i>		

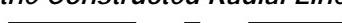
	RADIAL BLUE LINE		
1	SURANSHY BATYR KOSHESI	<i>The Ordinary station</i>	The Suranshy Batyr Street – angle of the Novaia Street
2	ABISHEV KOSHESI	<i>The Ordinary station</i>	The Abishev Street – angle of the Tazhibaev Street
3	BAIANAUL	<i>The Ordinary station</i>	The Tole Bi Street – angle of the lassau Street (the Baianaul Micro District)
4	AKSAI	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Tole Bi Street – angle of the Sain Street (the Aksai Micro District)
5	UTEGEN BATYR KOSHESI	<i>The Ordinary station</i>	The Utegen Batyr Street – Angle of the Tole Bi Street
6	TASTAK	<i>The Interchange node with the Planned Radial Line</i> 	The Tole Bi Street – angle of the Turkebaev Street
7	KUDERIN KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Kuderin Street – Angle of the Borzov Street
8	GALILEY KOSHESI	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Raiymbek Avenue – angle of the Galiley Street
9	ALEKSEYEV KOSHESI	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Alekseev Street – angle of the Raiymbek Avenue
10	WOKZAL ALMATY-2	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Abylai Khan Avenue – angle of the Tuzov Street (near the “Almaty-2 nd ” Raiway station)
11	RAIYMBEK BATYR	<i>The Interchange node with the Existing Radial Line</i> 	The Raiymbek Avenue – angle of the Tulebaev Street
12	KHAMIDI KOSHESI	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Khamidi Street – angle of the Mukhamedjanov Street
13	TATIBEKOV KOSHESI	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Tatibekov Street – angle of the Leninogorskaia Street
14	KAIRAT	<i>The Ordinary station</i>	The Tattimbet Street – angle of the Ryskulov Street (the Kairat village)
15	TERESHKOVA KOSHESI	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Bukhtarminskaia Street – angle of the Tereshkova Street
16	GULDALA	<i>The Ordinary station</i>	The Kuljinsky Trakt – angle of the Zhansugurov Street (the Guldala village)

17	KULJINSKY TRAKT	<i>The Ordinary station</i>	The Kuljinsky Trakt (near the Multilevel Highway intersection)
18	IBRAGIMOV KOSHESI	<i>The Ordinary station</i>	The Ibragimov Street (the Central part of the Alatay village)
X	<i>The Proposed RADIAL ORANGE LINE</i>		
1	ALMALYBAK	<i>The Ordinary station</i>	Near the Multilevel Highway intersection (the Almalybak village)
2	IRGELI	<i>The Ordinary station</i>	The Akzhol Street – angle of the Kunaev Street (the Irgelei village)
3	KOKSAI	<i>The Ordinary station</i>	The Zhana Gasyr Street – angle of the Arai Street (the Koksai village)
4	ALGABAS	<i>The Ordinary station</i>	The Kurylys Street – angle of the Zhetysu Street (the Algabas village)
5	AKBULAK	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Ryskulov Avenue – angle of the Zhumabekov Street (the Akbulak Micro District)
6	RYSKULOV DANGYLY	<i>The Ordinary station</i>	The Ryskulov Avenue – angle of the Yrstysty Street
7	KURLYYSSH	<i>The Ordinary station</i>	The Zhana Arka Street – angle of the Temir Kazyk Street (the Kurylysshi Micro District)
8	SEVERNOE KOLTSO KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Ryskulov Avenue – angle of the Severnoe Koltso Street
9	BOKEIKHANOV KOSHESI	<i>The Interchange node with the Proposed Radial BROWN Line</i> 	The Ryskulov Avenue – angle of the Bokeikhanov Street
10	KAZYBAEV KOSHESI	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Kazybaev Street – Angle of the Ryskulov Avenue
11	PRZHEVALSKY KOSHESI	<i>The Interchange node with the Proposed Radial YELLOW Line</i> 	The Przhevalsky Street – angle of the Shylov Street
12	KOTCHIN KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Kotchin Street – angle of the Ryskulov Avenue
13	ULKEN ALMATY ARNASY	<i>The Interchange node with the Proposed Radial CELADON Line</i> 	The Ryskulov Avenue – angle of the Gastello Street (near the Big Almaty Channel)
14	TATIBEKOV KOSHESI	<i>The Interchange node with the Proposed Radial BLUE Line</i>	The Tatibekov Street – angle of the Leninogorskaia

			Street
15	ATYRAY	 	The Kuljinsky Trakt – angle of the Ryskulov Avenue (the Atyrau Micro District)
16	BESAGASH	<i>The Ordinary station</i>	The Zhumabaev Street – angle of the Karasai Batyr Street (the Besagash village)
17	TYZDYBASTAU	<i>The Ordinary station</i>	The Zhalkybai Street – angle of the Aldabergenov Street (the Tyzdybastau village)
18	BELBULAK	<i>The Ordinary station</i>	The Abdygulov Street – angle of the Rechnaia Street (the Belbulak village)
19	BIRLIK	<i>The Ordinary station</i>	Near the School (the Birlik village)
20	KYZYLKAIRAT	<i>The Ordinary station</i>	Near the Multilevel Highway intersection (the Kyzylkairat village)
XI	<i>The Proposed RADIAL BROWN LINE</i>	 	
1	BATYSSHIL SAIABAK	<i>The Ordinary station</i>	Beside the Western Cemetery
2	KOK-KAINAR	<i>The Ordinary station</i>	The Ak-Kainar Street – angle of the Abai Street (the Kok-Kainar Micro District)
3	SHANYRAK	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Alpamys Street – angle of the Akyn Sara Street (the Shanyrak Micro District)
4	ULJAN	<i>The Ordinary station</i>	The Kokpekyt Street – angle of the Takezhanov Street (the Ulian Micro District)
5	ZARIA WOSTOKA	<i>The Interchange node with the Planned Radial Line</i> 	The Severnoe Koltso Street – angle of the Gvardeiskaia Street
6	MARKELOV KOSHESI	<i>The Ordinary station</i>	The Markelov Street – angle of the Bokeikhanov Street
7	BOKEIKHANOV KOSHESI	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Ryskulov Avenue – angle of the Bokeikhanov Street
8	GALILEY KOSHESI	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Raiymbek Avenue – angle of the Galiley Street
9	AITIYEV KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Aitiyev Street – angle of the Tole Bi Street

10	ALATAY	<i>The Interchange node with the Existing Radial Line</i> 	The Abai Avenue – angle of the Zharokov Street
11	ATAKENT	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Auezov Street – angle of the Timiriazev Street
12	TRAMPLIN	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Zhamakaev Street (near the Ski-jump Centre)
13	REMIZOVKA	<i>The Ordinary station</i>	The Remizovka Street – angle of the Zelionye Holmy Street (the Remizovka village)
XII	The Proposed RADIAL YELLOW LINE		
1	AKSENGIR	<i>The Ordinary station</i>	Near the Multilevel Highway intersection (the Aksengir village)
2	KOKUZEK	<i>The Ordinary station</i>	The Kokuzek village Central part
3	BORALDAI	<i>The Ordinary station</i>	The Bostanov Street – angle of the Abai Street
4	BORALDAI-AUEZHAI	<i>The Ordinary station</i>	The Abai Street (near the Boralundai Airport)
5	UZHET	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Ukel Ybrai Street – angle of the Seitov Street
6	DOROZHNİK	<i>The Interchange node with the Planned Radial Line</i> 	The Severnoe Koltso Street – angle of the Bokeikhanov Street
7	KULAGER	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Kazybaev Street – angle of the Serikov Street (the Kulager Micro District)
8	PRZHEVALSKY KOSHESI	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Przhevalsky Street – angle of the Shylov Street
9	SEIFULLIN DANGLY	<i>The Interchange node with the Planned Radial Line</i> 	The Seifullin Avenue – angle of the Zhansugurov Street
10	WOKZAL ALMATY-2	<i>The Interchange node with the Proposed Radial BLUE Line</i> 	The Abylai Khan Avenue – angle of the Tuzov Street (near the "Almaty-2nd" Raiway station)
11	GOGOL' KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Gogol' Street – angle of the Nauryzbai Batyr Street
12	KARASAI BATYR KOSHESI	<i>The Ordinary station</i>	The Karasai Batyr Street – angle of the Seifullin Avenue
13	BAYKONUR	<i>The Interchange node with</i>	The Abai Avenue –

		<i>the Existing Radial Line</i> 	Angle of the Baitursynov Street
14	TIMIRIAZEV KOSHESI	<i>The Ordinary station</i>	The Timiriazev Street – Angle of the Bal'zak Street
15	GORNY GIGANT	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Zhukov Street – angle of the Akhmediarov Street
16	BAIAJANOV KOSHESI	<i>The Ordinary station</i>	The Baiajanov Street – Angle of the Taimanov Street
17	TAU-SAMAL	<i>The Ordinary station</i>	The Zhantobe Street – angle of the Olimpiyskaia Street
XIII	<i>The Proposed RADIAL CELADON LINE</i>		
1	ZHAPEK BATYR	<i>The Ordinary station</i>	Near the Multilevel Highway intersection (the Zhapek Batyr village)
2	ASHIBULAK	<i>The Ordinary station</i>	The Tauelsyzdyk Street – angle of the Tsentral'naya Street (the Ashibulak village)
3	QOYANKOZ	<i>The Ordinary station</i>	The Abai Street – angle of the Zhambyl Street (the Quoankoz village)
4	ESENTAI	<i>The Interchange node with the Planned Radial Line</i> 	The Zhansugurov Street (near the Esentai bridge)
5	BEISEMBAEV KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Beisembaev Street – angle of the Onejskaia Street
6	KRASNO- GVARDEISKY TRAKT	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Suiunbai Avenue (near the "Detsky sad" Bus stop)
7	ALTAI	<i>The Ordinary station</i>	The Mailin Street – angle of the Lavreniov Street (the Altai Micro district)
8	ZHAS KANAT	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Fedoseev Street – angle of the Shemiakin Street (the Zhas Kanat Micro District)
9	SHEMIAKIN KOSHESI	<i>The Ordinary station</i>	The Kozhedub Street – angle of the Shemiakin Street
10	ULKEN ALMATY ARNASY	<i>The Interchange node with the Proposed Radial ORANGE Line</i> 	The Ryskulov Avenue – angle of the Gastello Street (near the Big Almaty Channel)
11	DZHANGILDIN KOSHESI	<i>The Ordinary station</i>	The Dzhangildin Street – Angle of the Bondarenko Street
12	KHAMIDI KOSHESI	<i>The Interchange node with the Proposed</i>	The Khamidi Street – angle of the Mukhamedjanov

		<i>Radial BLUE Line</i> 	Street
13	KOK BAZAR	<i>The Interchange node with the Planned Radial Line</i> 	The Gogol' Street – Angle of the Zenkov Street
14	KABANBAI BATYR KOSHESI	<i>The Ordinary station</i>	The Kabanbai Batyr Street – Angle of the Kaldaikov Street
15	SATBAEV KOSHESI	<i>The Ordinary station</i>	The Satbaev Street – Angle of the Lugansky Street
16	KOKTOBE	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Omarova Street (near the "Europolis-Promenade Complex")
17	OSPANOV KOSHESI	<i>The Ordinary station</i>	The Ospanov Street – angle of the Dostyk Avenue
18	BUTAKOVKA	<i>The Ordinary station</i>	The Gornaia Street – angle of the Beiseuov Street
XIV	<i>The Proposed RADIAL GREY LINE</i>		
1	TOLE BI KOSHESI	<i>The Interchange node with the Planned Radial Line</i> 	The Tole Bi Street – Angle of the Rozubakiev Street
2	ROZYBAKIEV KOSHESI	<i>The Interchange node with the Constructed Radial Line</i> 	The Abai Avenue – angle of the Rosybakiev Street
3	GAGARIN DANGLY	<i>The Interchange node with the Proposed Radial GREEN Line</i> 	The Gagarin Avenue – angle of the Timiriazev Street
4	BAIKADAMOV KOSHESI	<i>The Ordinary station</i>	The Baikadamov – angle of the Zharokov Street
5	ALMAGUL'	<i>The Ordinary station</i>	The Zharokov Street – angle of the Dunaevsky Street (the Almagul' Micro District)
6	KAZAKHFLIM	<i>The Interchange node with the Proposed Ring RED Line</i> 	The Isinaliev Street – angle of the Arychnaia Street (the Kazakhfilm Micro District)
7	KHAN-TENGRI	<i>The Ordinary station</i>	The Dulati Street – angle of the Almerek Street (the Khan-Tengri Micro District)
1	2	3	4

To ensure reliable operation of underground lines between stations located detour sections and deadlock sections. The length of detour sections allows overtaking, parking and change of direction. In the scheme three types of detour are used.

- Detour-1: the detour to the left of main tracks, the detour between of main tracks, the detour to the right of main tracks. The Detour-1 provides the ability to maneuver for five trains.



- Detour-2: the detour to the left of main tracks or the detour to the right of main tracks, the detour between of main tracks. The Detour-2 provides the ability to maneuver for four trains.

- Detour-3: the detour between of main tracks. The Detour-3 provides the ability to maneuver for three trains.

The length of deadlock sections allows parking and change of direction. Used three types of deadlocks.

- Deadlock-1: the deadlock to the left of main tracks, the deadlock between of main tracks, the deadlock to the right of main tracks, ends of main tracks. The Deadlock-1 provides the ability to maneuver for five trains.

- Deadlock-2: the deadlock to the left of main tracks or the deadlock to the right of main tracks, the deadlock between of main tracks, ends of main tracks. The Deadlock-2 provides the ability to maneuver for four trains.

- Deadlock-3: the deadlock between main tracks ends of main tracks. The Deadlock-3 provides the ability to maneuver for three trains.

Design features of subways in the Republic of Kazakhstan assessed by the relevant Chapter of Building Rules and Regulations [253].

1.4 Development Stages of the Almaty Metro Ring-Radial network

The proposed sequence of development is based on a system that consists of an existing line, the line being built and planned lines. The most appropriate plan of development is the Triad: THE RING LINE – EXTERNAL RADIUS LINES, WHICH CONNECTED ONLY WITH THE RING LINE – COMBINING EXTERNAL RADIAL LINES INTO DIAMETRICAL LINES. This method, for example, has been successfully implemented in the development of the Moscow Metro in Second half of 20 Century. The Almaty Metro development consists of five successive stages.

THE FIRST STAGE OF THE RING-RADIAL SCHEME DEVELOPMENT – the Ring line construction (26 new stations, 18 new interchange nodes).

Under construction line of this Development Stage:

The Ring Line: *ALMATY-AUEZHAI (the New station; the New Interchange node with the Proposed Radial Line) – TERESHKOVA KOSHESI (the New station; the New Interchange node with the Proposed Radial Line) – ATYRAY (the New station; the New Interchange node with the Proposed Radial Line) – DUMAN (the New station; the New Interchange node with the Planned Radial Line) – SHOKAI KOSHESI (the New station) – KOKTOBE (the New station; the New Interchange node with the Proposed Radial Line) – GORNYI GIGANT (the New station; the New Interchange node with the Proposed Radial Line) – TRAMPLIN (the New station; the New Interchange node with the Proposed Radial Line) – BAGANASHIL (the New station) – KAZAKHFILEM (the New station; the New Interchange node with the Proposed Radial Line) – NAVOI KOSHESI (the New station) – ORBITA (the New station; the New Interchange node with the Planned Radial Line) – TAUGUL' (the New station; the New Interchange node with the Proposed Radial Line) – SARYARKA (the New station; the New Interchange node with the Planned Radial Line) – ZHUBANOV KOSHESI (the New station) – AKSAI (the New station; the New Interchange node with the Proposed Radial Line) – AKBULAK (the New station; the New Interchange node with the Proposed Radial Line) – AIGERIM (the New station) – SHANYRAK (the New station; the New Interchange node with the Proposed Radial Line) – DARKHAN (the New station) – UZHET (the New station; the New Interchange node with the Proposed Radial Line) – TSCHERIOMUSHKI (the New station; the New Interchange node with the Planned Radial Line) – ZHANSUGUROV KOSHESI (the New station) – WOKZAL ALMATY-1 (the New station; the New Interchange node with the Planned Radial Line) –

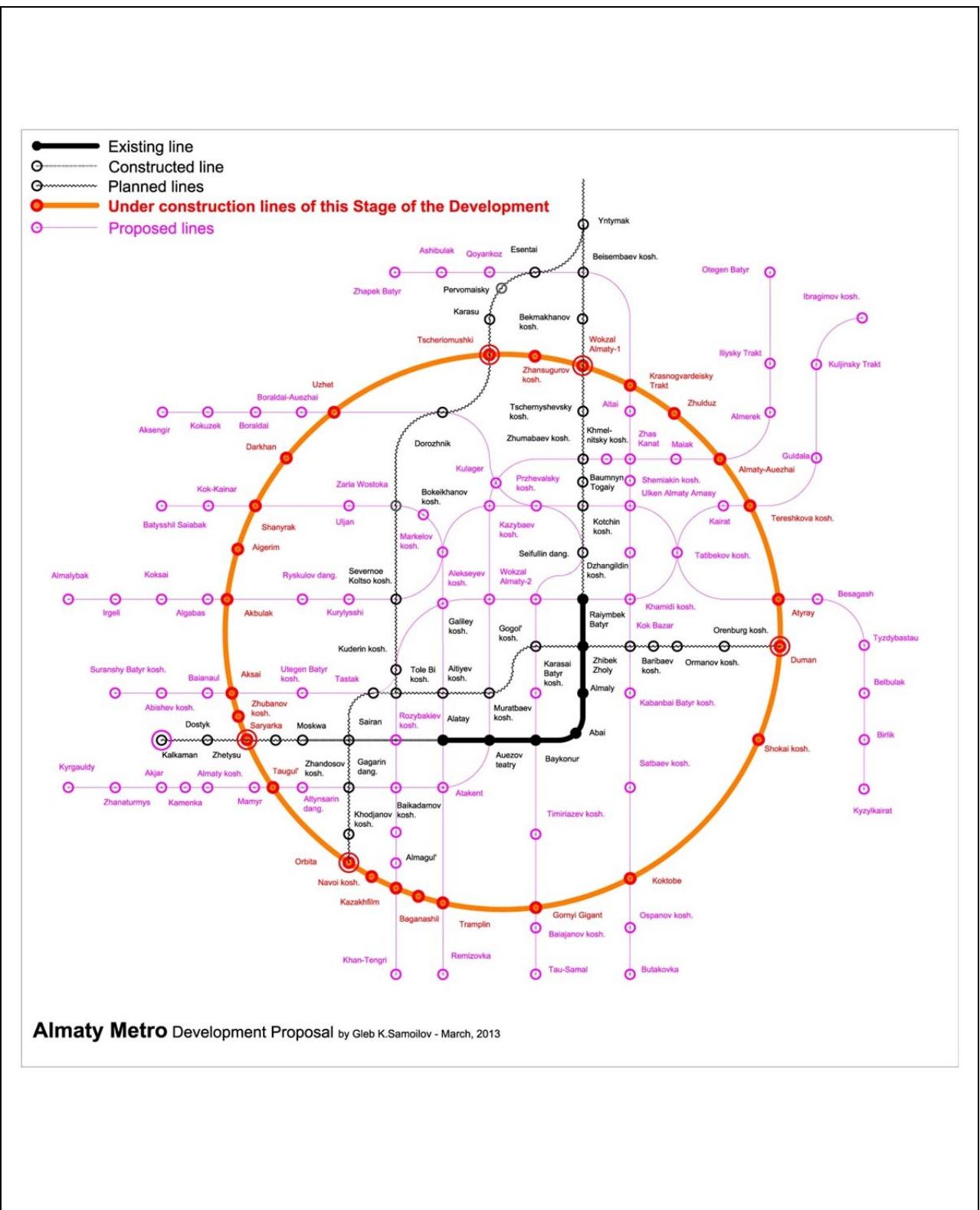


Figure 18.
 The First Stage
 of the Almaty Metro Ring-Radial scheme development.

Images source:
Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

KRASNOGVARDEISKY TRAKT (the New station; the New Interchange node with the Proposed Radial Line) – ZHULDUZ (the New station)*.

The First Stage of the Ring-Radial scheme development is shown in the Figure 18.

THE SECOND STAGE OF THE RING-RADIAL SCHEME DEVELOPMENT – Radial Lines construction (54 new stations, 15 operated interchange nodes). New thirteen Lines are arranged on the outer side of the Ring.

Under construction Lines of this Development Stage:

The 1st outer portion of Lines (4 new stations, 1 operated interchange node): SURANSHY BATYR KOSHESI (the New station) – ABISHEV KOSHESI (the New station) – BAIANAUL (the New station) – AKSAI (the New station; the operated Interchange node with the Ring Line).

The 2nd outer portion of Lines (4 new stations, 1 operated interchange node): TERESHKOVA KOSHESI (the New station; the operated Interchange node with the Ring Line) – GULDALA (the New station) – KULJINSKY TRAKT (the New station) – IBRAGIMOV KOSHESI (the New station).

The 3rd outer portion of Lines (7 new stations, 1 operated interchange node): KYRGAUPLY (the New station) – ZHANATURMYS (the New station) – AKJAR (the New station) – KAMENKA (the New station) – ALMATY KOSHESI (the New station) – MAMYR (the New station) – TAUGUL' (the New station; the operated Interchange node with the Ring Line)

The 4th outer portion of Lines (4 new stations, 1 operated interchange node): ALMATY AUEZHAI (the New station; the operated Interchange node with the Ring Line) – ALMEREK (the New station) – ILIYSKY TRAKT (the New station) – OTEGEN BATYR (the New station).

The 5th outer portion of Lines (5 new stations, 1 operated interchange node): ALMALYBAK (the New station) – IRGELI (the New station) – KOKSAI (the New station) – ALGABAS (the New station) – AKBULAK (the New station; the operated Interchange node with the Ring Line).

The 6th outer portion of Lines (6 new stations, 1 operated interchange node): ATYRAY (the New station; the operated Interchange node with the Ring Line) – BESAGASH (the New station) – TYZDYBASTAU (the New station) – BELBULAK (the New station) – BIRLIK (the New station) – KYZYLKAIRAT (the New station).

The 7th outer portion of Lines (3 new stations, 1 operated interchange node): BATYSSHIL SAIABAK (the New station) – KOK-KAINAR (the New station) – SHANYRAK (the New station; the operated Interchange node with the Ring Line).

The 8th outer portion of Lines (2 new stations, 1 operated interchange node): TRAMPLIN (the New station; the operated Interchange node with the Ring Line) – REMIZOVKA (the New station).

The 9th outer portion of Lines (5 new stations, 1 operated interchange node): AKSENGIR (the New station) – KOKUZEK (the New station) – BORALDAI (the New station) – BORALDAI-AUEZHAI (the New station) – UZHET (the New station; the operated Interchange node with the Ring Line).

The 10th outer portion of Lines (3 new stations, 1 operated interchange node): GORNY GIGANT (the New station; the operated Interchange node with the Ring Line) – BAIAJANOV KOSHESI (the New station) – TAU-SAMAL (the New station).

The 11th outer portion of Lines (6 new stations, 3 operated interchange nodes): ZHAPEK BATYR (the New station) – ASHIBULAK (the New station) – QOYANKOZ (the New station) – ESENTAI (the New station; the operated Interchange node with the Radial Line) – BEISEMBAEV KOSHESI (the New station; the operated Interchange node with the Radial Line) – KRASNOGVARDEISKY TRAKT (the New station; the operated Interchange node with the Ring Line).

The 12th outer portion of Lines (3 new stations, 1 operated interchange node): KOKTOBE (the New station; the operated Interchange node with the Ring Line) – OSPANOV KOSHESI (the New station) – BUTAKOVKA (the New station).

The 13th outer portion of Lines (2 new stations, 1 operated interchange node): KAZAKHFILM (the New station; the Operated Interchange node with the Ring Line) – KHAN-TENGRI (the New station).

The Second Stage of the Ring-Radial scheme development is shown in the Figure 19.

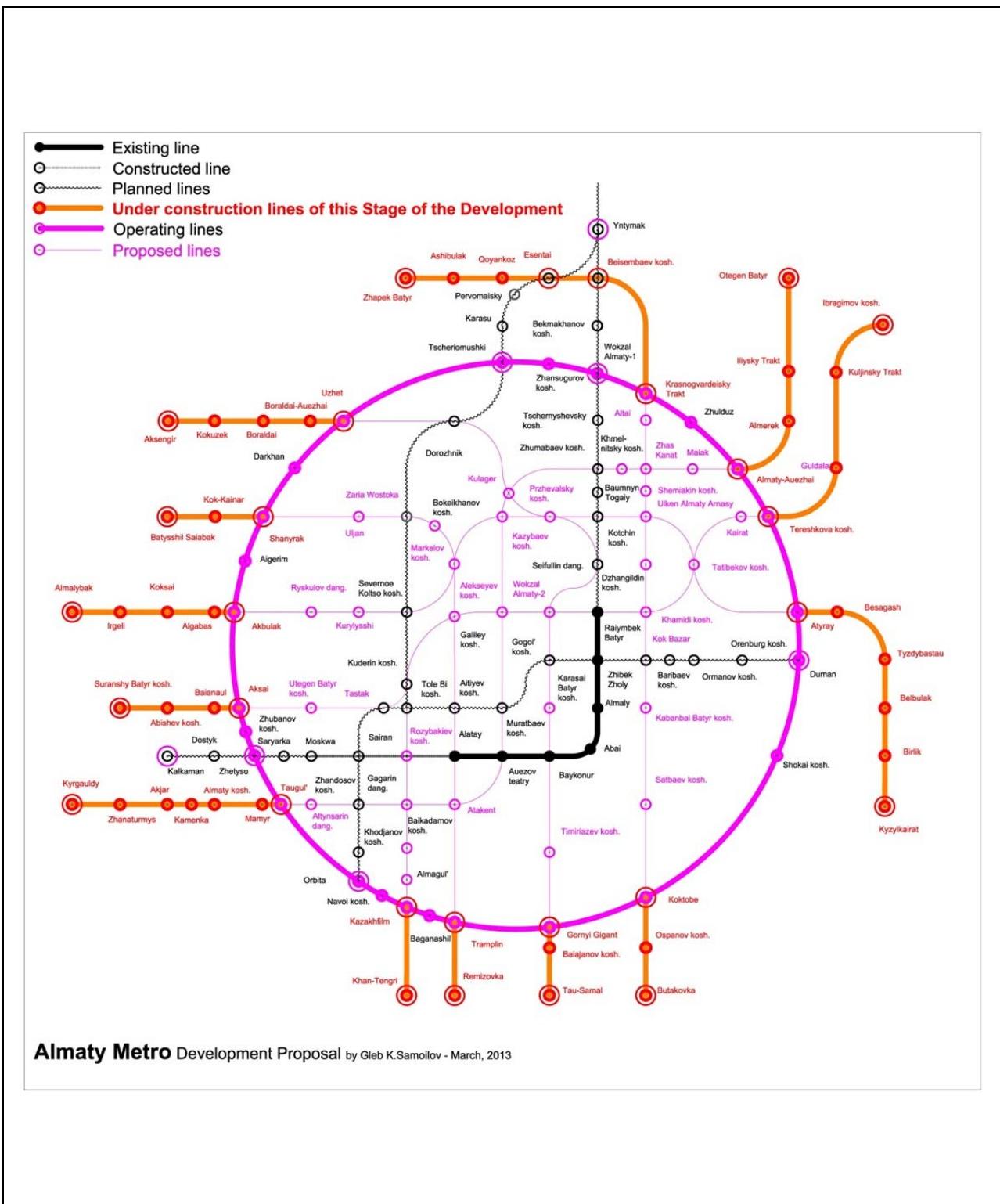


Figure 19.
The Second Stage
of the Almaty Metro Ring-Radial scheme development.

*Images source:
 Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).*

THE THIRD STAGE OF THE RING-RADIAL SCHEME DEVELOPMENT – the Radial lines construction (21 new stations, 4 operated stations, 6 operated interchange nodes, 10 new interchange nodes). New two (the 1st, the 2nd) lines are arranged on the inner side of the Ring.

Under construction lines of this Development Stage:

The 1st inner portion of lines (13 new stations, 2 operated stations, 4 operated interchange nodes, 6 new interchange nodes): TAUGUL' (the Operated station, the operated Interchange node with the Ring Line) – ALTYNSARIN DANGYLY (the New station) – ZHANDOSOV KOSHESI (the New station, the operated Interchange node with the Radial Line) – GAGARIN DANGYLY (the New station, the new Interchange node with the Radial Line) – ATAVENT (the New station, the new Interchange node with the Radial Line) – AUEZOV TEATRY (the New station, the operated Interchange node with the Radial Line) – MURATBAEV KOSHESI (the New station, the operated Interchange node with the Radial Line) – ALEKSEEV KOSHESI (the New station, the new Interchange node with the Radial Line) – KAZYBAEV KOSHESI (the New station, the new Interchange node with the Radial Line) – KULAGER (the New station, the new Interchange node with the Radial Line) – ZHUMABAEV KOSHESI (the New station, the operated Interchange node with the Radial Line) – KHAMELNITSKY KOSHESI (the New station) – ZHAS KANAT (the New station, the new Interchange node with the Radial Line) – MAIAK (the New station) – ALMATY AUEZHAI (the Operated station, the operated Interchange node with the Ring Line).

The 2nd inner portion of lines (9 new stations, 2 operated stations, 2 operated interchange nodes, 5 new interchange nodes): AKBULAK (the Operated station, the operated Interchange node with the Ring Line) – RYSKULOV DANGYLY (the New station) – KURYLYSSHI (the New station) – SEVERNOE KOLTSO KOSHESI (the New station, the operated Interchange node with the Radial Line) – BOKEIKHANOV KOSHESI (the New station, the new Interchange node with the Radial Line) – KAZYBAEV KOSHESI (the New station, the new Interchange node with the Radial Line) – PRZHEVALSKY KOSHESI (the New station, the new Interchange node with the Radial Line) – KOTCHIN KOSHESI (the New station, the operated Interchange node with the Radial Line) – ULKEN ALMATY ARNASY (the New station, the new Interchange node with the Radial Line) – TATIBEKOV KOSHESI (the New station, the new Interchange node with the Radial Line) – ATYRAY (the Operated station, the operated Interchange node with the Ring Line).

The Third Stage of the Ring-Radial scheme development is shown in the Figure 20.

THE FOURTH STAGE OF THE RING-RADIAL SCHEME DEVELOPMENT – the Radial lines construction (35 new stations, 6 operated stations, 13 operated interchange nodes, 3 new interchange nodes). New three (the 3rd, the 4th, 5th) lines are arranged on the inner side of the Ring.

Under construction lines of this Development Stage:

The 3rd inner portion of lines (10 new stations, 2 operated stations, 3 new interchange nodes, 6 operated interchange nodes): AKSAI (the Operated station, the operated Interchange node with the Ring Line) – UTEGEN BATYR KOSHESI (the New station) – TASTAK (the New station, the operated Interchange node with the Radial Line) – KUDERIN KOSHESI (the New station, the operated Interchange node with the Radial Line) – GALILEY KOSHESI (the New station, the new Interchange node with the Radial Line) – ALEKSEYEV KOSHESI (the New station, the operated Interchange node with the Radial Line) – WOKZAL ALMATY-2 (the New station, the new Interchange node with the Radial Line) – RAIYMBEK BATYR (the New station, the operated Interchange node with the Radial Line) – KHAMIDI KOSHESI (the New station, the new Interchange node with the Radial Line) – TATIBEKOV KOSHESI (the New station, the operated Interchange node with the Radial Line) – KAIRAT (the New station) – TERESHKOVA KOSHESI (the Operated station, the operated Interchange node with the Ring Line).

The 4th inner portion of lines (9 new stations, 2 operated station, 1 new interchange node, 8 operated interchange nodes): UZHET (the Operated station, the operated Interchange node with the Ring Line) – DOROZHNIK (the New station, the operated Interchange node with the Radial Line) – KULAGER (the New station, the operated Interchange node with the Radial Line) – PRZHEVALSKY KOSHESI (the New station, the operated Interchange node with the Radial Line) – SEIFULLIN DANGYLY (the New station, the operated Interchange node with the Radial Line) – WOKZAL ALMATY-2 (the New

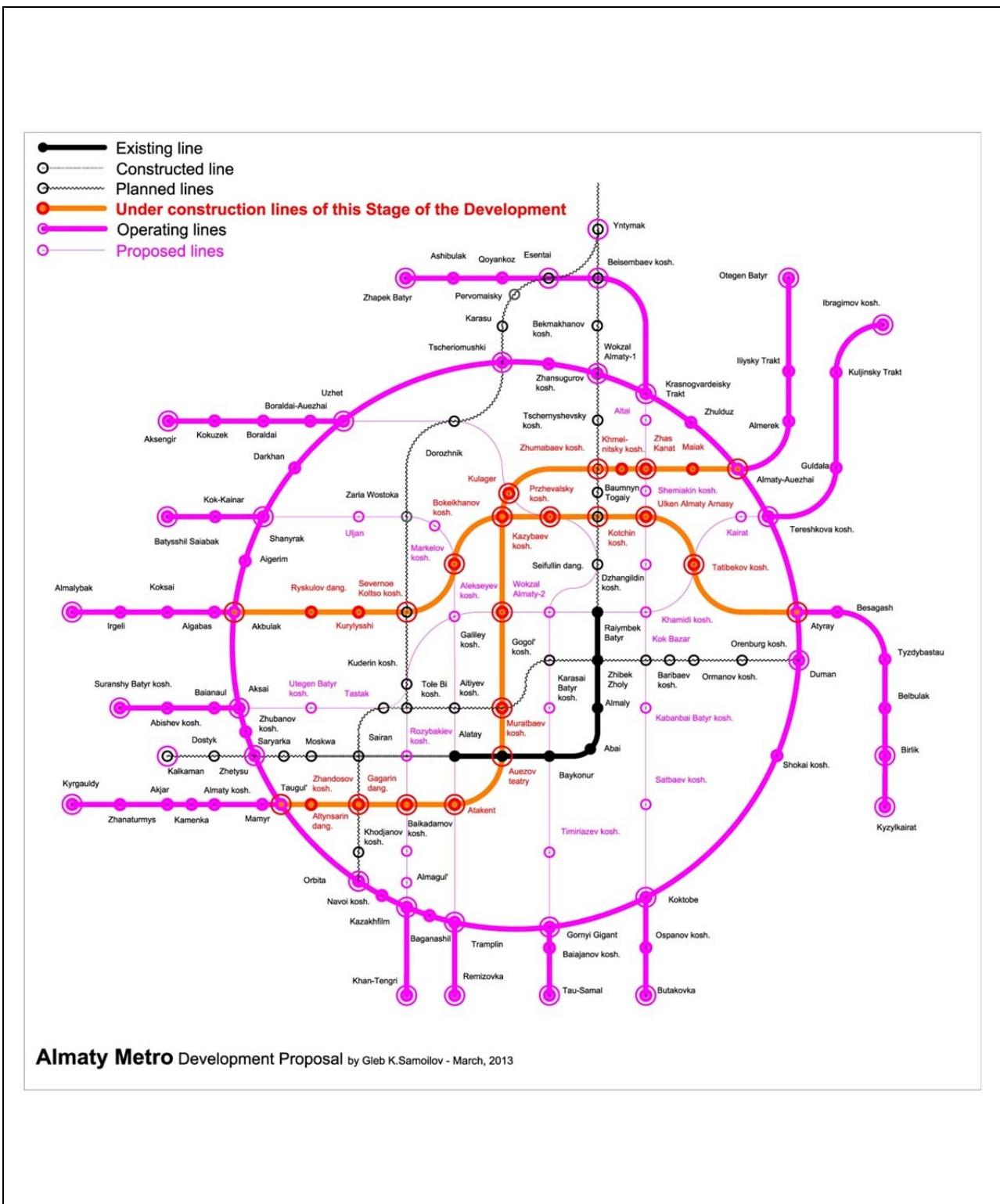


Figure 20.
 The Third Stage
 of the Almaty Metro Ring-Radial scheme development.

Images source:
 Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

THE ALMATY METRO RING-RADIAL NETWORK (Prospects of creation and integration in the Urban Public Transport system) *Research Paper by GLEB K.SAMOILOV, 2014*

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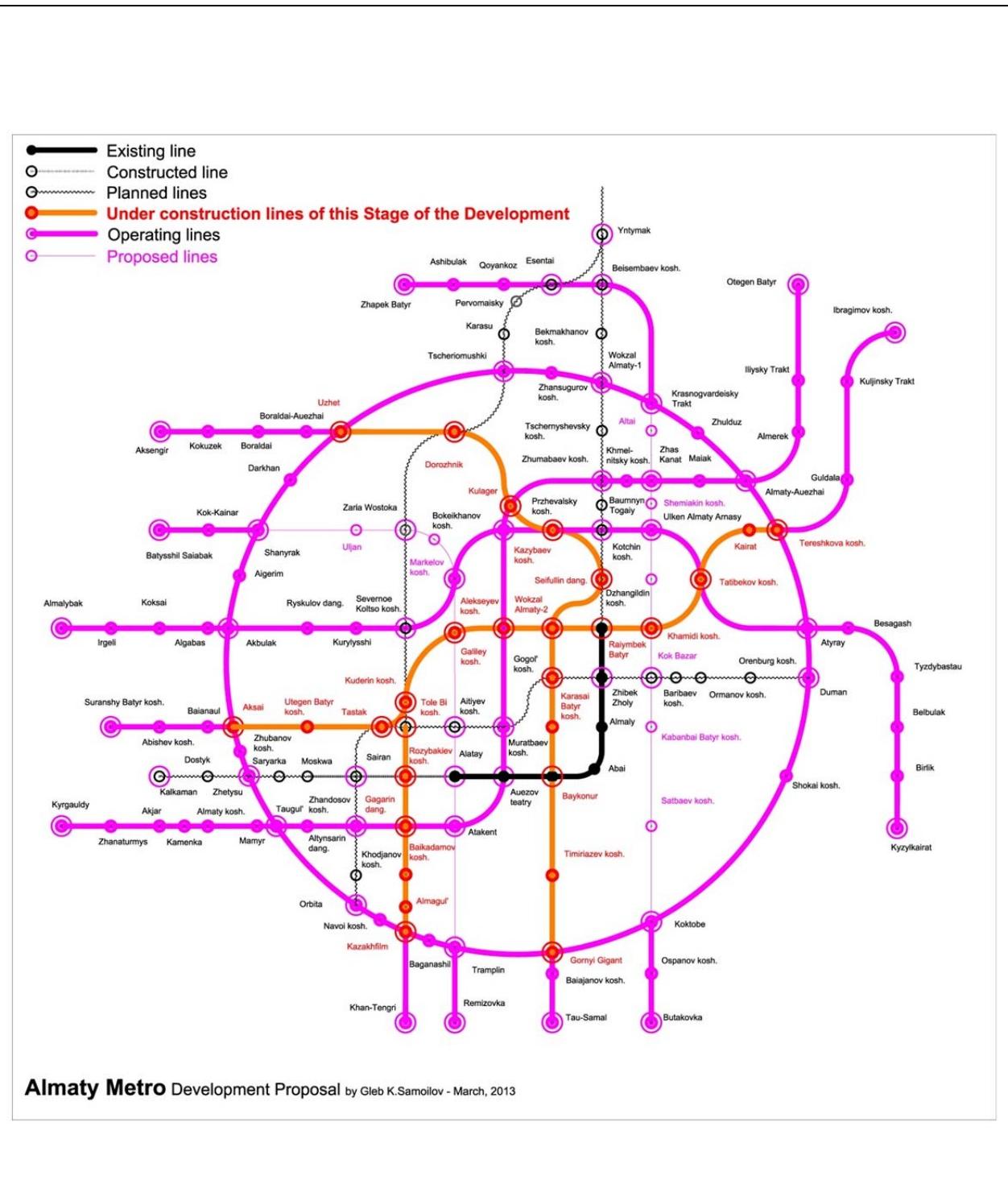


Figure 21.
The Fourth Stage
of the Almaty Metro Ring-Radial scheme development.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

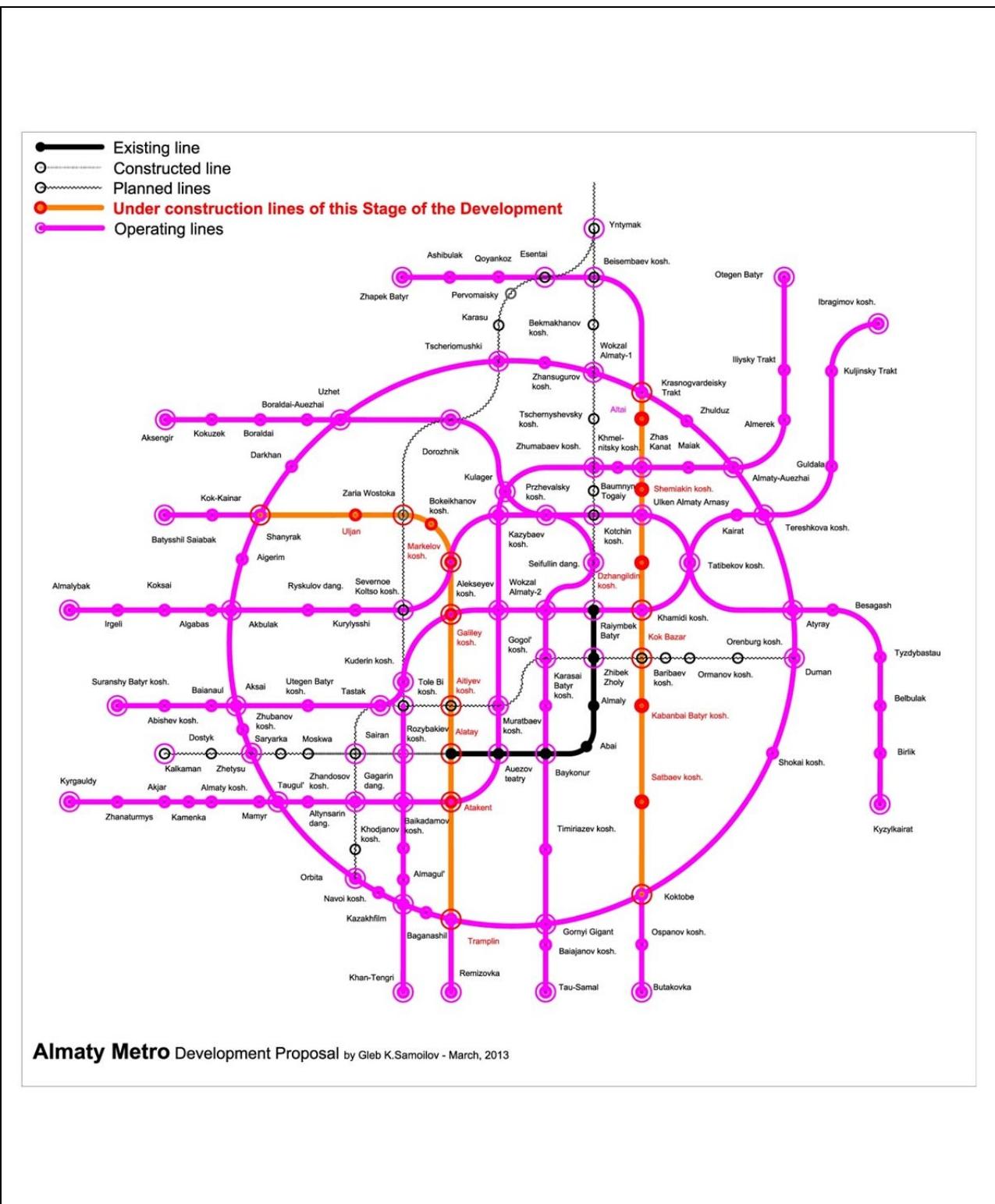


Figure 22.
 The Fifth Stage
 of the Almaty Metro Ring-Radial scheme development.

Images source:
 Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

station, the new Interchange node with the Radial Line) – GOGOL' KOSHESI (the New station, the operated Interchange node with the Radial Line) – KARASAI BATYR KOSHESI (the New station) – BAYKONUR (the New station, the operated Interchange node with the Radial Line) – TIMIRIAZEV KOSHESI (the New station) – GORNY GIGANT (the Operated station, the Interchange node with the Ring Line).

The 5th inner portion of lines (2 new stations, 2 operated stations, 4 operated interchange nodes): TOLE BI KOSHESI (the Operated station, the operated Interchange node with the Radial Line) – ROZYBAKIEV KOSHESI (the New station, the operated Interchange node with the Radial Line) – GAGARIN DANGYLY (the New station, the operated Interchange node with the Radial Line) – KAZAKHFILEM (the Operated station, the operated Interchange node with the Ring Line).

The Fourth Stage of the Ring-Radial scheme development is shown in the Figure 21.

THE FIFTH STAGE OF THE RING-RADIAL SCHEME DEVELOPMENT - the Radial lines construction (19 new stations, 4 operated stations, 14 operated interchange nodes). New two (the 6th, the 7th) lines are arranged on the inner side of the Ring.

Under construction lines of this Development Stage:

The 6th inner portion of lines (10 new stations, 2 operated stations, 8 operated interchange nodes): SHANYRAK (the Operated station, the operated Interchange node with the Ring Line) – ULJAN (the New station) – ZARIA WOSTOKA (the New station, the operated Interchange node with the Radial Line) – MARKELOV KOSHESI (the New station) – BOKEIKHANOV KOSHESI (the New station, the operated Interchange node with the Radial Line) – GALILEY KOSHESI (the New station, the operated Interchange node with the Radial Line) – AITIYEV KOSHESI (the New station, the operated Interchange node with the Radial Line) – ALATAY (the New station, the operated Interchange node with the Radial Line) – ATAKENT (the New station, the operated Interchange node with the Radial Line) – BAIKADAMOV KOSHESI (the New station) – ALMAGUL' (the New station) – TRAMPLIN (the Operated station, the operated Interchange node with the Ring Line).

The 7th inner portion of lines (9 new stations, 2 operated stations, 6 operated interchange nodes): KRASNOGVARDEISKY TRAKT (the Operated station, the operated Interchange node with the Ring Line) – ALTAI (the New station) – ZHAS KANAT (the New station, the operated Interchange node with the Radial Line) – SHEMIAKIN KOSHESI (the New station) – ULKEN ALMATY ARNASY (the New station, the operated Interchange node with the Radial Line) – DZHANGILDIN KOSHESI (the New station) – KHAMIDI KOSHESI (the New station, the operated Interchange node with the Radial Line) – KOK BAZAR (the New station, the operated Interchange node with the Radial Line) – KABANBAI BATYR KOSHESI (the New station) – SATBAEV KOSHESI (the New station) – KOKTOBE (the Operated station, the operated Interchange node with the Ring Line).

The Fifth Stage of the Ring-Radial scheme development is shown in the Figure 22.

Formation of the Almaty Metro Ring-Radial network (after completion of the Constructed line and four planned lines) can be done not only with sections of lines (Five stages).

THE ALTERNATIVE – IS CONSTRUCTION OF LINE GROUPS (Three stages).

ON THE FIRST (ALTERNATIVE) STAGE may construct four radial lines (the Green Radial Line, the Blue Radial Line, the Yellow Radial Line, the Grey Radial Line):

The Proposed Radial GREEN Line (24 stations, 12 interchange nodes): Kyrgauldy – Zhanaturmys – Akjar – Kamenka – Almaty koshesi – Mamyr – Taugul' (the Interchange node with the Proposed Ring RED Line) – Altynsarın dangly – Zhandosov koshesi (the Interchange node with the Planned Radial Line) – Gagarin dangly (the Interchange node with the Proposed Radial GREY Line) – Atakent (the Interchange node with the Proposed Radial BROWN Line) – Auezov Teatry (the Interchange node with the Existing Line) – Muratbaev koshesi (the Interchange node with the Planned Radial Line) – Alekseev koshesi (the Interchange node with the Proposed Radial BLUE Line) – Kazybaev koshesi (the Interchange node with the Proposed Radial ORANGE Line) – Kulager (the Interchange node with the Proposed Radial YELLOW Line) – Zhumabaev koshesi (the Interchange node with the Planned Radial Line) – Khmelknitsky koshesi – Zhas Kanat (the Interchange node with the Proposed Radial CELADON

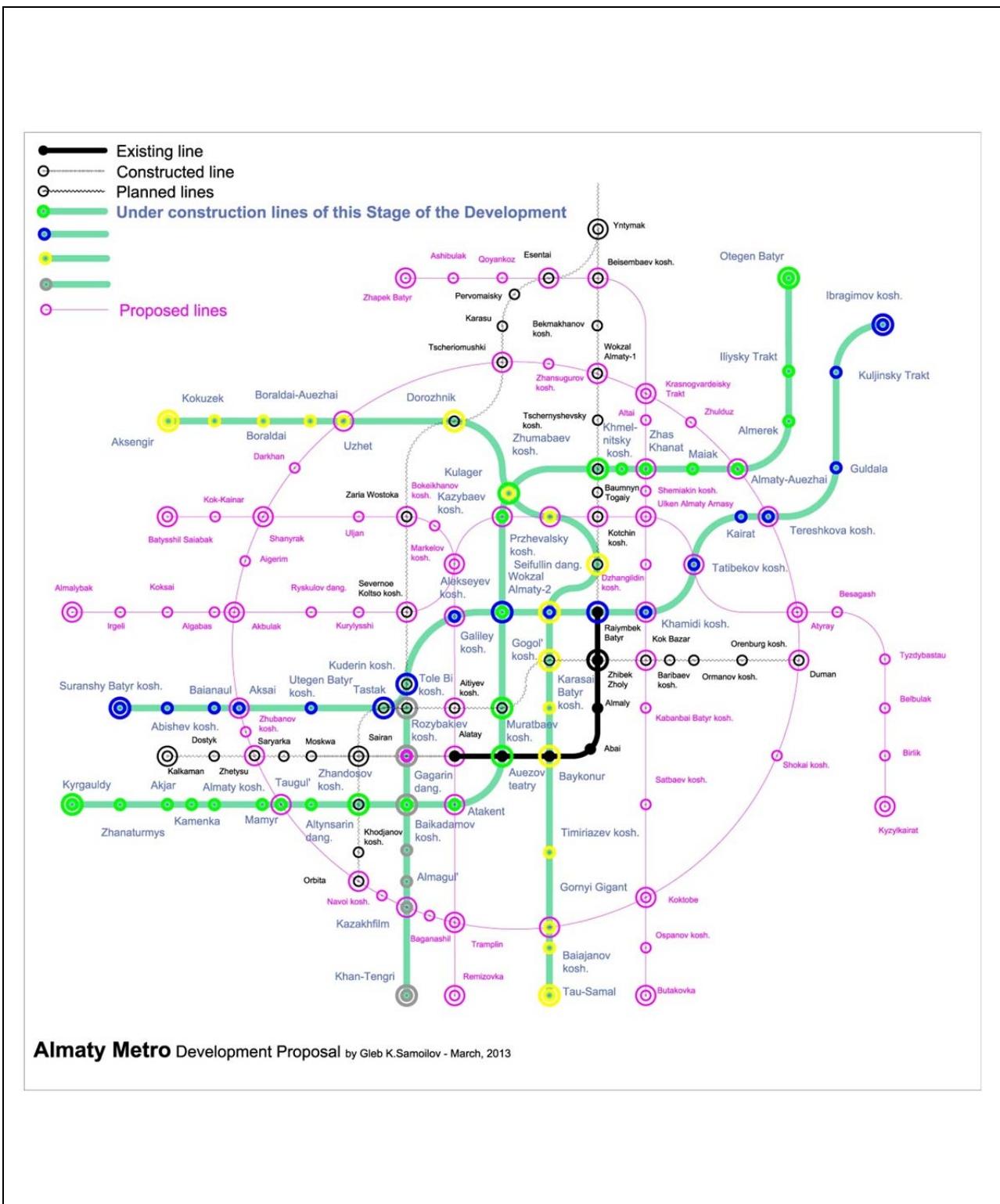


Figure 23.
 The First Alternative Stage
 of the Almaty Metro Ring-Radial scheme development.

Images source:

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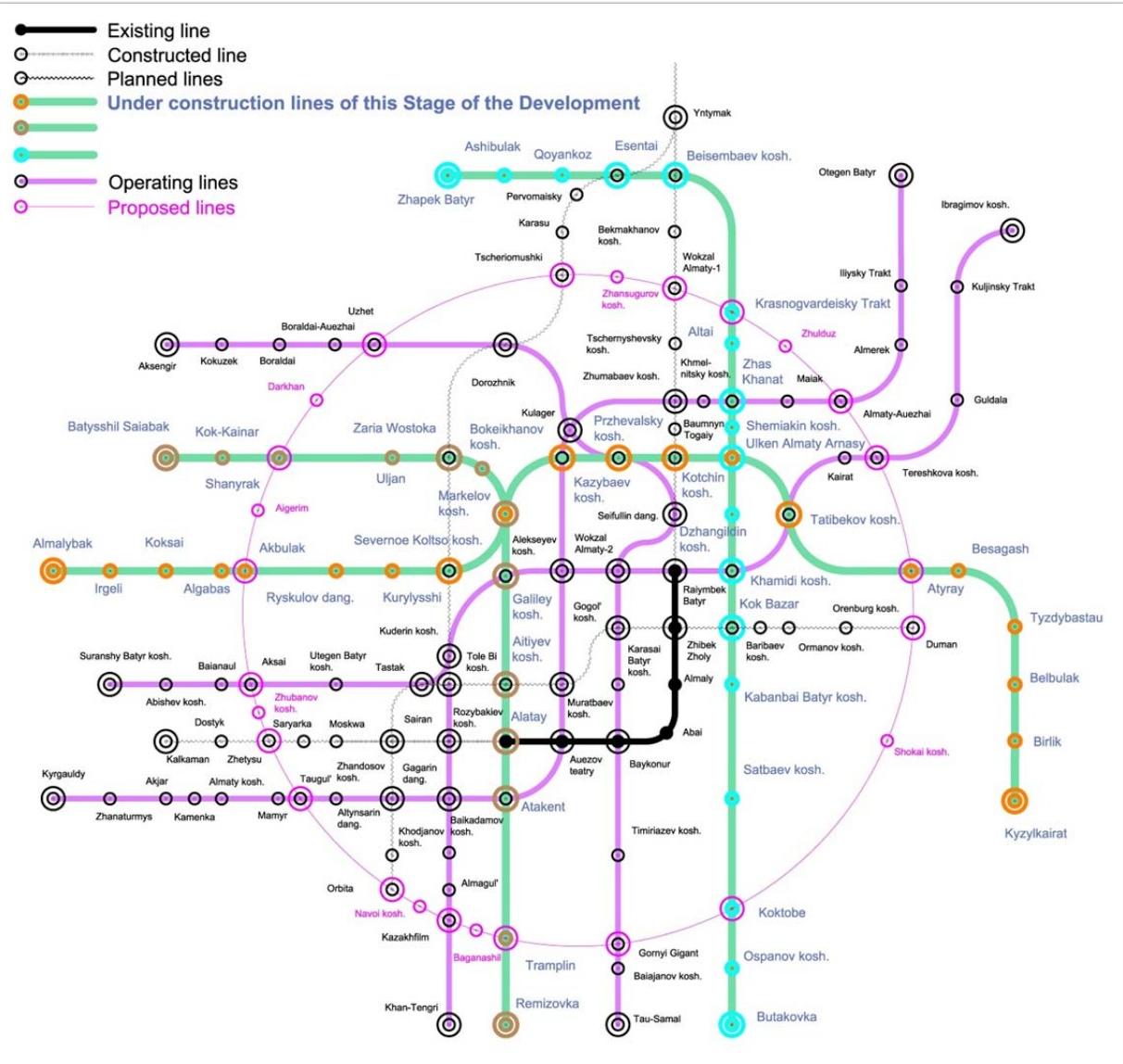


Figure 24.
The Second Alternative Stage
of the Almaty Metro Ring-Radial scheme development.

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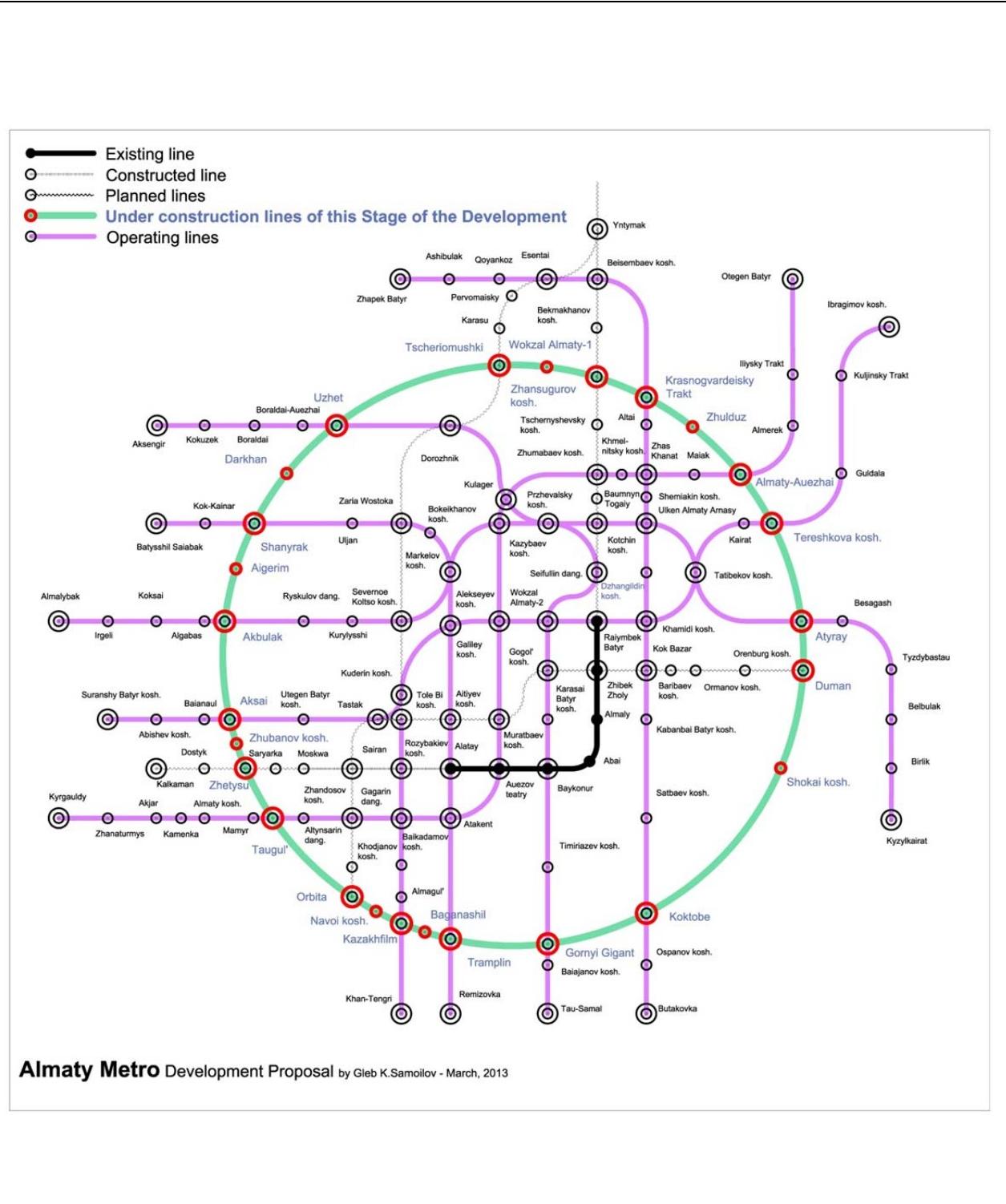


Figure 25.
The Third Alternative Stage
of the Almaty Metro Ring-Radial scheme development.

Images source:

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Line) – Maiak – Almaty Auezhai (the Interchange node with the Proposed Ring RED Line) – Almerek – Iliysky Trakt – Otegen Batyr.

The Proposed Radial BLUE Line (18 stations, 10 interchange nodes): Suranshy Batyr koshesi – Abishev koshesi – Baianaul – Aksai (the Interchange node with the Proposed Ring RED Line) – Utegen Batyr koshesi – Tastak (the Interchange node with the Planned Radial Line) – Kuderin koshesi (the Interchange node with the Planned Radial Line) – Galiley koshesi (the Interchange node with the Proposed Radial BROWN Line) – Alekseyev koshesi (the Interchange node with the Proposed Radial GREEN Line) – Wokzal Almaty-2 (the Interchange node with the Proposed Radial YELLOW Line) – Raiymbek Batyr (the Interchange node with the Existing Line / Planned Radial Line) – Khamidi koshesi (the Interchange node with the Proposed Radial CELADON Line) – Tatibekov koshesi (the Interchange node with the Proposed Radial ORANGE Line) – Kairat – Tereshkova koshesi (the Interchange node with the Proposed Ring RED Line) – Guldala – Kuljinsky Trakt – Ibragimov koshesi.

The Proposed Radial YELLOW Line (17 stations, 9 interchange nodes): Aksengir – Kokuzek – Boraldai – Boraldai-Auezhai – Uzhet (the Interchange node with the Proposed Ring RED Line) – Dorozhnik (the Interchange node with the Planned Radial Line) – Kulager (the Interchange node with the Proposed Radial GREEN Line) – Przhevalsky koshesi (the Interchange node with the Proposed Radial ORANGE Line) – Seifullin dangly (the Interchange node with the Planned Radial Line) – Wokzal Almaty-2 (the Interchange node with the Proposed Radial BLUE Line) – Gogol' koshesi (the Interchange node with the Planned Radial Line) – Karasai Batyr koshesi – Baykonur (the Interchange node with the Existing Line) – Timiriazev koshesi – Gorny Gigant (the Interchange node with the Proposed Ring RED Line) – Baiajanov koshesi – Tau-Samal.

The Proposed Radial GREY Line (5 stations, 4 interchange nodes): Tole Bi koshesi (the Interchange node with the Planned Radial Line) – Rozybakiev koshesi (the Interchange node with the Constructed Line) – Gagarin dangly (the Interchange node with the Proposed Radial GREEN Line) – Kazakhfilm (the Interchange node with the Proposed Ring RED Line) – Khan-Tengri.

The First Alternative Stage of the Ring-Radial scheme development is shown in the Figure 23.

ON THE SECOND (ALTERNATIVE) STAGE may construct three radial lines (the Orange Radial Line, the Brown Radial Line, the Celadon Radial Line):

The Proposed Radial ORANGE Line (20 stations, 9 interchange nodes): Almalybak – Irgeli – Koksai – Algabas – Akbulak (the Interchange node with the Proposed Ring RED Line) – Ryskulov dangly – Kurylysshi – Severnoe Koltso koshesi (the Interchange node with the Planned Radial Line) – Bokeikhanov koshesi (the Interchange node with the Proposed Radial BROWN Line) – Kazybaev koshesi (the Interchange node with the Proposed Radial GREEN Line) – Przhevalsky koshesi (the Interchange node with the Proposed Radial YELLOW Line) – Kotchin koshesi (the Interchange node with the Planned Radial Line) – Ulken Almaty Arnasy (the Interchange node with the Proposed Radial CELADON Line) – Tatibekov koshesi (the Interchange node with the Proposed Radial BLUE Line) – Atyray (the Interchange node with the Proposed Ring RED Line) – Besagash – Tyzdybastau – Belbulak – Birlik – Kyzylkairat.

The Proposed Radial BROWN Line (13 stations, 8 interchange nodes): Batysshil Saiabak – Kok-Kainar – Shanyrak (the Interchange node with the Proposed Ring RED Line) – Uljan – Zaria Wostoka (the Interchange node with the Planned Radial Line) – Markelov koshesi – Bokeikhanov koshesi (the Interchange node with the Proposed Radial ORANGE Line) – Galiley koshesi (the Interchange node with the Proposed Radial BLUE Line) – Aitiyev koshesi (the Interchange node with the Planned Radial Line) – Alatay (the Interchange node with the Existing Line) – Atakent (the Interchange node with the Proposed Radial GREEN Line) – Baikadamov koshesi – Almagul' – Tramplin (the Interchange node with the Proposed Ring RED Line) – Remizovka.

The Proposed Radial CELADON Line (18 stations, 8 interchange nodes): Zhapek Batyr – Ashibulak – Qoyankoz – Esentai (the Interchange node with the Planned Radial Line) – Beisembaev koshesi (the Interchange node with the Planned Radial Line) – Krasnogvardeisky Trakt (the Interchange node with the Proposed Ring RED Line) – Altai – Zhas Kanat (the Interchange node with the Proposed Radial GREEN Line) – Shemiakin koshesi – Ulken Almaty Arnasy (the Interchange node with the Proposed

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Figure 26.
The Form
of the Almaty Metro developed Radial-Ring system.

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Radial ORANGE Line) – Dzhangildin koshesi – Khamidi koshesi (the Interchange node with the Proposed Radial BLUE Line) – Kok Bazar (the Interchange node with the Planned Radial Line) – Kabanbai Batyr koshesi – Satbaev koshesi – Koktobe (the Interchange node with the Proposed Ring RED Line) – Ospanov koshesi – Butakovka.

The Second Alternative Stage of the Ring-Radial scheme development is shown in the Figure 24.

ON THE THIRD (ALTERNATIVE) STAGE may construct the Ring line (the Red Ring Line):

The Proposed Ring RED Line (26 stations, 18 interchange nodes): *Almaty-Auezhai (the Interchange node with the Proposed Radial GREEN Line) – Tereshkova koshesi (the Interchange node with the Proposed Radial BLUE Line) – Atyray (the Interchange node with the Proposed Radial ORANGE Line) – Duman (the Interchange node with the Planned Radial Line) – Shokai koshesi – Koktobe (the Interchange node with the Proposed Radial CELADON Line) – Gornyi Gigant (the Interchange node with the Proposed Radial YELLOW Line) – Tramplin (the Interchange node with the Proposed Radial BROWN Line) – Baganashil – Kazakhfilm (the Interchange node with the Proposed Radial GREY Line) – Navoi koshesi – Orbita (the Interchange node with the Planned Radial line) – Taugul' (the Interchange node with the Proposed Radial GREEN Line) – Saryarka (the Interchange node with the Planned Radial Line) – Zhurbanov koshesi – Aksai (the Interchange node with the Proposed Radial BLUE Line) – Akbulak (the Interchange node with the Proposed Radial ORANGE Line) – Aigerim – Shanyrak (the Interchange node with the Proposed Radial BROWN Line) – Darkhan – Uzhet (the Interchange node with the Proposed Radial YELLOW Line) – Tscheriomushki (the Interchange node with the Planned Radial Line) – Zhansugurov koshesi – Wokzal Almaty-1 (the Interchange node with the Planned Radial Line) – Krasnogvardeisky Trakt (the Interchange node with the Proposed Radial CELADON Line) – Zhulduz*.

The Third Alternative Stage of the Ring-Radial scheme development is shown in the Figure 25.

The finished form of the developed Radial-Ring system of Almaty Metro is a convenient off-street Passenger transport network with 188 stations and 55 interchange nodes on 10 lines.

The Form of the developed Radial-Ring system is shown in the Figure 26.

The result is easily accessible in all areas of passenger traffic, and numerous interchange nodes will give the opportunity to choose the best route. This will create a system of sustainable off-street traffic. Well-functioning system of integrated public transport will significantly reduce the number of cars on streets of the city by reducing the number of buses, and by providing a convenient alternative to personal vehicles.

Conclusions of the First Chapter

Held in the First chapter analysis led to following conclusions:

1. In the end of the 1950s a significant increase of the Almaty city territory and increase passenger traffic has made the task of forming the speed off-street transport system an actual. The most promising type of such transport was considered Metro.
2. In mid-1970s performed the project of the monorail for magnetic levitation trains. This project was not implemented.
3. In the early 1980s, performed the project of the Metro. This project is beginning to be realized in the late 1980s. During the construction on the project was introduced a number of changes:
 - eliminated the Third line;
 - reduced the number of stations on the First stage of the construction;
 - changing the length of the First line;
 - changing the type of the interchange node between the First and the Second lines;
 - changing the Second line trace position and the interchange node between the First and the Second lines;
 - there is a new Third line;
 - changing the staging of the project implementation;
 - changing of the Second and the Third line traces;
 - there is a site of integration of the First and the Second lines with the High-speed railway.

4. At the turn of 2000-2010s some interesting proposals for the development of the Metro network and the formation of an integrated transport system were published.
5. In 2010-2013, performed projects of other modes of High speed off-street transport: the Light Rail Transit (LRT) and the Bus Rapid Transit (BRT). The LRT-route uses part of the existing tram line. However, the implementation of the LRT system has a number of difficulties:
 - dedicated line for the High-speed traffic in the middle of streets requires the creation of a plurality of multi-level road intersections (planned route passes through the territory, where the intersections are located every 150 m);
 - for High-speed line required large turning radius than those that are on existing tram lines;
 - for the formation of an normative arc is necessary to reconstruct the existing buildings in the areas of turns.The Combined version of the LRT network (convenient for road traffic) – ground stops / underground movements – have not prospects, as its cost is comparable to the cost of the Metro.
6. The implementing scheme of the Metro (the existing line – 7 stations, constructed line – 2 station and the planned lines – 32 stations) does not cover all potential passengers.
7. The proposed scheme of the Metro development – the Ring line and several radial/diametric lines as a supplement of the implementing scheme: the Total number of stations 188; the Existing line (7 stations, 5 interchange nodes); the Constructed line (3 stations, 2 interchange nodes); Planned lines (37 stations, 24 interchange nodes); Proposed lines (139 stations, 59 interchange nodes).
8. This scheme covers almost all potential passengers: provides convenient links between residential areas, the City centre, sport complexes, industrial areas, shopping centers, recreation zones, airports, railway stations and bus stations, which are located in the Big Almaty Ring Road.
9. Implementation of the proposed Ring-radial scheme is possible in two ways:
 - the Ring line – outer portions of radial lines – the inner portion of radial lines (five stages);
 - radial lines – the Ring line (three stages).

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Chapter 2

THE IMPROVEMENT OF THE ALMATY URBAN PASSENGER TRANSPORT INTEGRATED SYSTEM



2.1

The Integration of the Developed Metro network with other modes of the Public transport

The ALMATY INTEGRATED PUBLIC TRANSPORT SYSTEM is the result of the link between transit and end points of the Railway service, the Airway service, and the Intercity Bus service (an External transport) with the Developed network of the Metro, the Bus service, the Trolleybus service and the Taxi service (an Internal transport).

Almaty International and Long distance Domestic Passenger Transport consists of the Airway service, the Railway service and the Bus service. The proposed Developed Radial-Ring network of the Almaty Metro is integrated with different types of external transport:

- the RAILWAY SERVICE – new Metro stations at existing Railway stations "Almaty-1" (the Planned line / the Proposed Ring line "Red"), "Almaty-2" (the Proposed Radial line "Blue" / the Proposed Radial line "Green"), the new Metro station with the new High-speed Railway Station "Yntymak" (planned lines);

- the AIRWAY SERVICE – new Metro stations at the existing Airway terminals "Almaty Airport" (the Proposed Ring line "Red" / the Proposed Radial line "Green") and "Boraldai Airport" (the Proposed Radial line "Yellow");

- the INTERCITY BUS SERVICE – new metro stations at new bus stations on the Big Almaty Ring Road: "Kyrgauldy" (the Proposed Radial line "Green"), "Suranshy Batyr koshesi" (the Proposed Radial line "Blue"), "Almalybak" (the Proposed Radial line "Orange"), "Aksengir" (the Proposed Radial line "Yellow"), "Zhapek Batyr" (the Proposed Radial line "Celadon"), "Otegen Batyr" (the Proposed Radial line "Green"), "Kuljinsky Trakt" (the Proposed Radial line "Blue"), "Kyzylkairat" (the Proposed Radial line "Orange").

Integrated points of the Almaty Metro Developed network with the Airway service, the Railway service and the Intercity Bus service are shown in the Figure 26.

The Integration Concept of inner-city on-street passenger transport on the basis of the Metro: the Bus service from outside the Ring Line and the Trolleybus service inside the Ring Line. Bus stations are located at the ending stations of radial lines. Trolleybus stations are located at the interchange nodes of the Ring Line. The proposed Developed Radial-Ring network of the Almaty Metro is integrated with Bus- and Trolleybus services:

- the BUS SERVICE AT METRO STATIONS OUTSIDE THE RING LINE – 15 Bus stations at ending stations "Kalkaman" and "Yntymak" (planned lines), "Zhapek Batyr" and "Butakovka" (the Proposed Radial line "Celadon"), "Almalybak" and "Kyzylkairat" (the Proposed Radial line "Orange"), "Kyrgauldy" and "Otegen Batyr" (the Proposed Radial line "Green"), "Batysshyl Saiabak" and "Remizovka" (the Proposed Radial line "Brown"), "Suranshy Batyr koshesi" and "Kuljinsky Trakt" (the Ending station and the Penultimate station of the proposed Radial line "Blue"), "Aksengir" and "Tau-Samal" (the Proposed Radial line "Yellow"), "Khan Tengri" (the Proposed Radial line "Grey"). 32 Bus stops are located on other stations (the Ring line and outer portions of radial lines);

- the BUS SERVICE AT METRO STATIONS ON THE RING LINE – 26 Bus stops are located on all stations of the Proposed Ring Line "Red";

- the TROLLEYBUS SERVICE AT METRO STATIONS ON THE RING LINE – 18 Trolleybus stations are located on all interchange nodes of the Proposed Ring Line "Red";

- the TROLLEYBUS SERVICE AT METRO STATIONS INSIDE THE RING LINE – 61 Trolleybus stops are located on all stations inside of the Proposed Ring Line "Red".

Integrated points of the Almaty Metro Developed network with the Bus service and the Trolleybus service are shown in the Figure 27.

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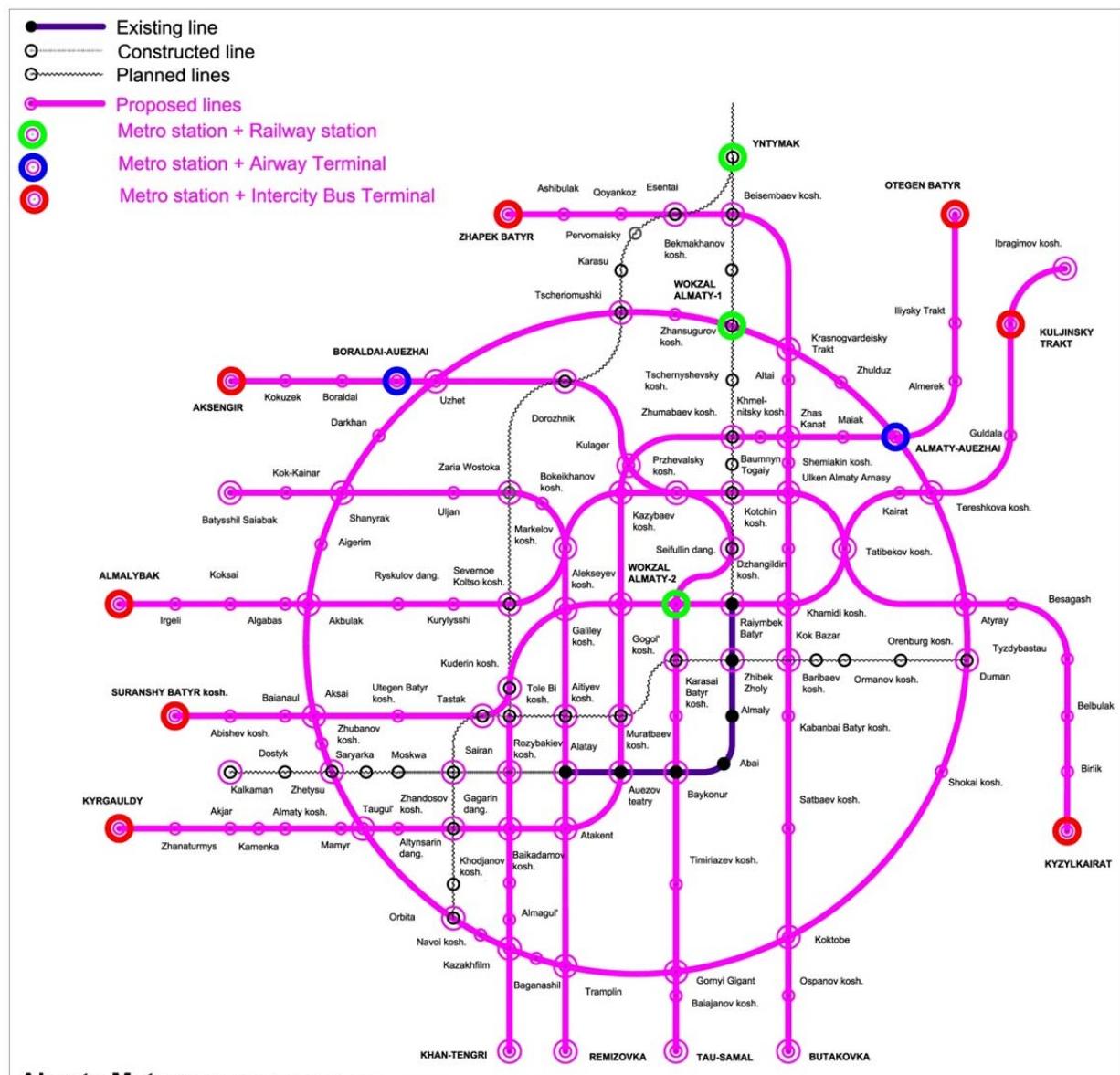


Figure 26.
**Integrated points of the Almaty Metro Developed network
 with the Airway service, the Railway service and the Intercity Bus service.**

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Figure 27.
Integrated points of the Almaty Metro Developed network with the Bus service and the Trolleybus service.

*Images source:
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Figure 28.
Integrated points of the Almaty Metro Developed network with the Taxi-service.

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The proposed Developed Radial-Ring network of the Almaty Metro is integrated with Taxi-service – the Taxi Hub and the Taxi Stop. Taxi hubs: Intercity bus stations, the High-speed Railway station, the Domestic Airport, the Western Cemetery, the Express-bus stop (to the Sport Complex "Medeu-Shymbulak"), all interchange nodes of the Ring Line (including the Railway Station and the International Airport), Railway Station, major transportation nodes, sports and entertainment complexes, shopping malls – 38 points. Taxi stops at all other Metro stations – 96 points.

- the TAXI SERVICE AT METRO STATIONS OUTSIDE THE RING LINE – 13 taxi hubs: the new ending metro station of the Planned line "Kalkaman"; the new ending metro station – the High-speed Railway Station of the Planned line "Yntymak"; new metro stations at new Bus stations on the Big Almaty Ring Road - "Kyrgauldy", "Suranshi Batyr koshesi", "Almalybak", "Aksengir", "Zhapek Batyr", "Otegen Batyr", "Kulzhinsky Trakt", "Kyzylkairat"; the new metro station at the Airterminal "Boraldai Auezhai"; the new metro station at the West Cemetery "Batysshyl Sayabak"; the new metro station "Butakovka" – walks to the Skating-rink Medeu and the Ski resort Shymbulak. 34 taxi stops: at 6 new metro stations on the planned metro lines; at 28 new metro stations on the proposed lines.

- the TAXI SERVICE AT METRO STATIONS ON THE RING LINE – 18 taxi hubs: at new metro stations (interchange nodes) on the planned lines - "Duman", "Orbita", "Zhetsu", "Tscheriomushki", "Wokzal Almaty-1"; at new metro stations (interchange nodes) on the proposed lines - "Almaty Auezhai" and "Taungul" (the Radial line "Green"), "Krasnogvardeisky Trakt" and "Koktyube" (the Radial line "Celadon"), "Darkhan" and "Gornyi Gigant" (the Radial line "Yellow"), "Shanyrak" and "Tramplin" (the Radial line "Brown"), "Akbulak" and "Atyrau" (the Radial line "Orange"), "Aksai" and "Tereshkova koshesi" (the Radial line "Blue"), "Kazakhfilm" (the Radial line "Grey"). 8 taxi stops: at new metro station on the Ring Line.

- the TAXI SERVICE AT METRO STATIONS INSIDE THE RING LINE – 7 taxi hubs: at the existing metro station (proposed interchange node) "Auezov teatr", at new metro stations on planned lines (proposed interchange nodes) "Tastak", "Kok Bazar", "Kotchin koshesi", "Zaria Wostoka", at new stations on the proposed lines (interchange nodes) "Wokzal Almaty-2" and "Atakent". 55 taxi stops: at 6 existing metro stations, at 49 new stations of constructed, planned and proposed lines.

Integrated points of the Almaty Metro Developed network with the Taxi-service are shown in the Figure 28.

2.2 The Integration of the Developed Metro network with the Private transport

Developed network of parking at Metro stations serves as the Park-and-Ride. This reduces the time required to travel as well as advanced Metro network allows faster and easier to navigate within the network. This has implications for episodic and periodic movements of the pendulum. In this case the Central part of the movement is on the Metro, with subsequent lease or personal use of a Scooter or a Bicycle, and on the periphery – in his or leased vehicle (a Car, a Scooter, a Motorcycle, a Bicycle).

For cross-cutting (diametrical or chord) movement has developed the Value System of Rental Vehicles. In this case the Central part of the movement is on the Metro, and on the periphery (to the Metro station or from the Metro station) – on his or leased vehicle (the Car, the Scooter, the Motorcycle, the Bicycle). The proposed Radial-Ring network of the Almaty Metro is integrated with Private transport (Cars, Scooters, Bicycles):

- the SERVICE FOR PRIVATE TRANSPORT AT METRO STATIONS OUTSIDE THE RING LINE – 19 Surface car parkings: at ending stations "Kalkaman" and "Yntymak", interchange nodes "Esental" and "Beisembayeva koshesi" (planned lines), "Zhapek Batyr" and "Butakovka" (the Proposed Radial line "Celadon"), "Almalybak" and "Kyzylkairat" (the Proposed Radial line "Orange"), "Kyrgauldy" and "Otegen Batyr" (the Proposed Radial line "Green"), "Batysshyl Saiabak" and "Remizovka" (the Proposed Radial line "Brown"), "Suranshy Batyr koshesi" and "Ibragimov koshesi" and also the new Bus station "Kuljinsky Trakt"

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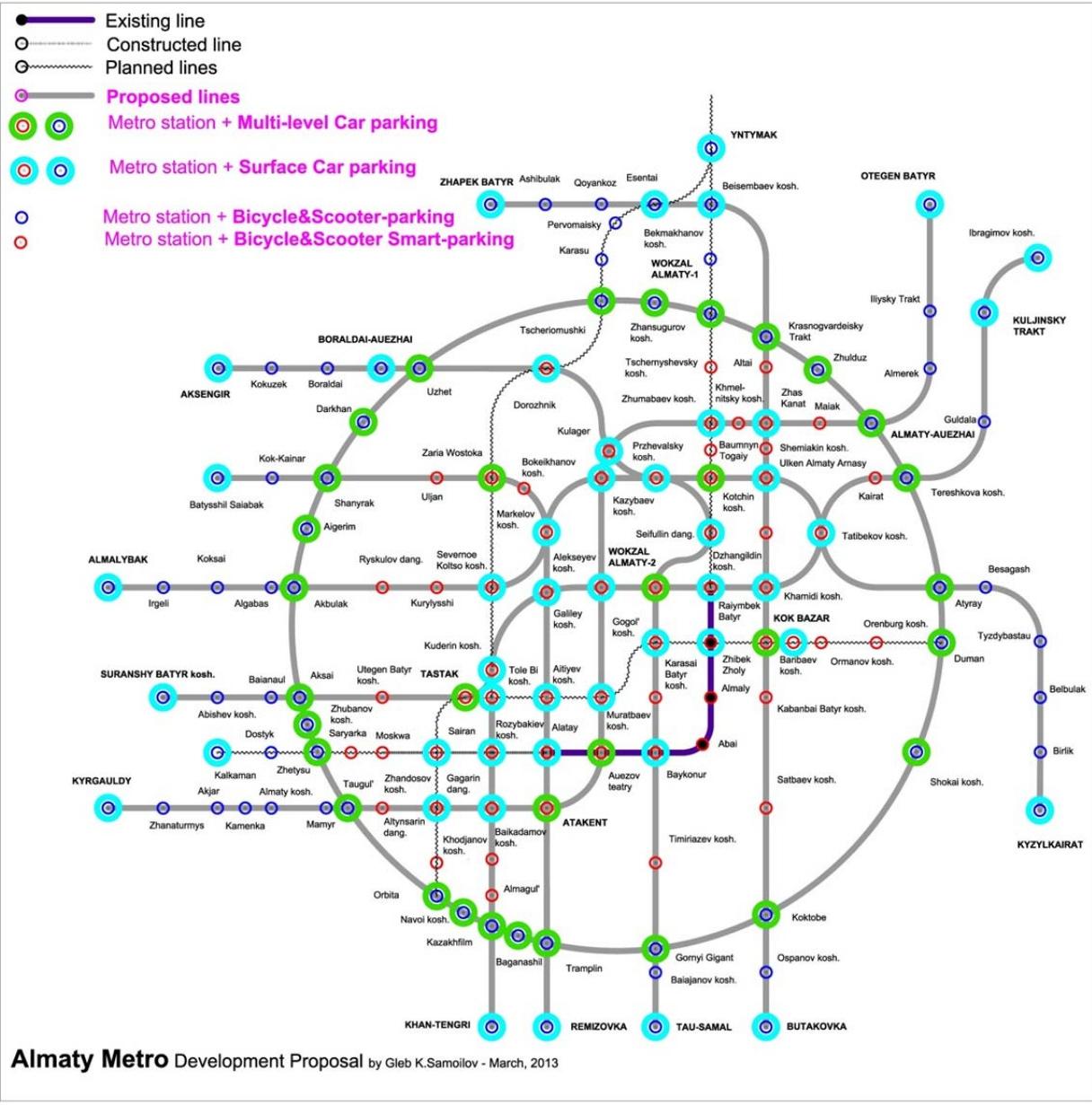


Figure 29.
Integrated points of the Almaty Metro Developed network
with the Private transport (Cars, Scooters, Bicycles).

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

(the Proposed Radial line "Blue"), "Aksengir" and "Tau-Samal", as well at the Air-terminal "Boraldai-Auezhai" (the Proposed Radial line "Yellow"), "Khan Tengri" (the Proposed Radial line "Grey"). 46 Bicycle&Scooter parkings are located at other stations.

- the SERVICE FOR PRIVATE TRANSPORT AT METRO STATIONS ON THE RING LINE – 26 Multi-level car parkings and Bicycle&Scooter parkings are located at all stations (the Proposed Ring Line "Red").

- the SERVICE FOR PRIVATE TRANSPORT AT METRO STATIONS INSIDE THE RING LINE – 7 Multi-level parkings at metro stations "Wokzal Almaty-2", "Kotchin koshesi", "Kok Bazar", "Zaria Wostoka", "Tastak", "Auezov teatry", "Atakent" and 28 Surface car parkings at all other stations – interchange nodes and station "Baribaev koshesi" (the Main entrance to the City Park of Culture and Leisure), 62 Bicycle&Scooter Smart parkings at each stations.

Integrated points of the Almaty Metro Developed network with the Private transport (Cars, Scooters, Bicycles) are shown in the Figure 29.

2.3

The Urban Passenger Transport Integrated system based on the Developed Metro network

The Integrated system of Public and Private Transport includes the following types of contacts on Metro stations: The METRO INTERCHANGE NODE + The AIRWAY SERVICE + The RAILWAY SERVICE + The INTERCITY BUS SERVICE + The BUS STATION + The BUS STOP + The TROLLEYBUS STATION + The TROLLEYBUS STOP + The TAXI-HUB + The TAXI-STOP + The MULTI-LEVEL CAR PARKING + The SURFACE CAR PARKING + The BICYCLE & SCOOTER SMART-PARKING + The BICYCLE & SCOOTER-PARKING. There are: Integration of Airway-, Railway- and Intercity Bus services; Integration of Bus and Trolleybus services; Integration of Taxi-service; Integration of Private transport (Cars, Scooters, Bicycles).

Different combinations of contacts form five types (17 sub-types) of integration nodes: 7 contacts (A, B), 6 contacts (A, B, C), 5 contacts (A, B, C, D, E), 4 contacts (A, B, C, D, E), 3 contacts (A, B).

Different modes of the Public and the Private Transport integration nodes with the Almaty Metro Developed Network are shown in the Figure 30.

The 7A Type of the Node: The Metro Interchange node + The AIRWAY SERVICE + The Bus stop + The Trolleybus station + The Taxi-hub + The Multi-level Car parking + The Bicycle & Scooter-parking.
1 point: Almaty Auezhai.

The 7B Type of the Node: The Metro Interchange node + The RAILWAY SERVICE + The Bus stop + The Trolleybus station + The Taxi-hub + The Multi-level Car parking + The Bicycle & Scooter-parking.
1 point: Wokzal Almaty-1.

The 6A Type of the Node: The Metro Interchange node + The RAILWAY SERVICE + The Trolleybus stop + The Taxi-hub + The Multi-level Car parking + The Bicycle & Scooter Smart-parking.
1 point: Wokzal Almaty-2.

The 6B Type of the Node: The Metro Interchange node + The RAILWAY SERVICE + The Bus station + The Taxi-hub + The Surface Car parking + The Bicycle & Scooter-parking.
1 point: Yntymak.

The 6C Type of the Node: The Metro Interchange node + The Bus stop + The Trolleybus station + The Taxi-hub + The Multi-level Car parking + The Bicycle & Scooter-parking.
16 points: Zhetsu, Orbita, Duman, Tscheriomushki, Atyray, Akbulak, Koktobe, Krasnogvardeisky Trakt, Tereshkova koshesi, Aksai, Gornyi Gigant, Uzhet, Tramplin, Shanyrak, Kazakhfilm, Taugul'.

The 5A Type of the Node: The AIRWAY SERVICE + The Bus stop + The Taxi-hub + The Surface Car parking + The Bicycle & Scooter-parking.

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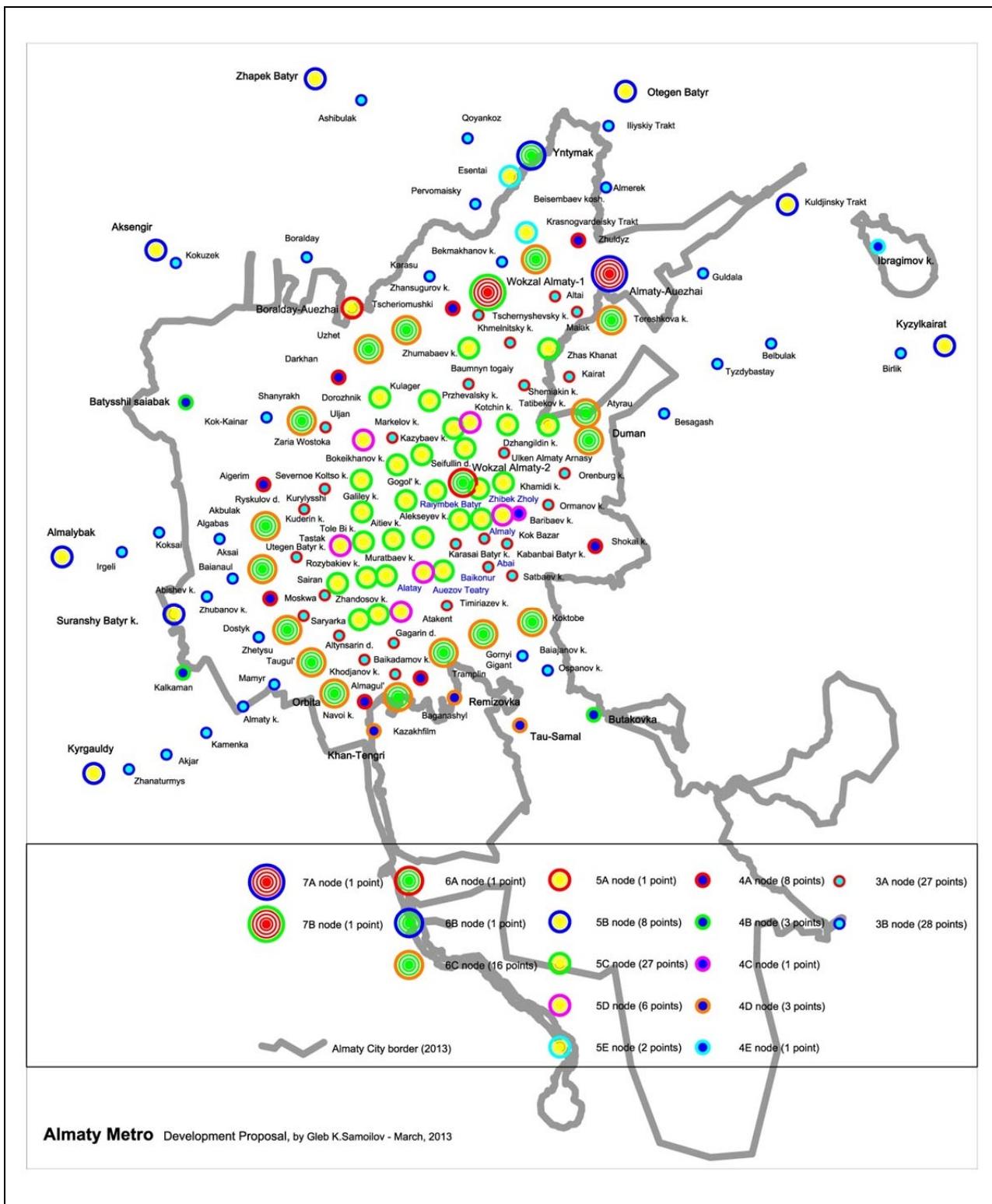


Figure 30.
Different modes of the Public and the Private Transport integration nodes with the Almaty Metro Developed Network.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

1 point: Boraldai-Auezhai.

The 5B Type of the Node: The INTERCITY BUS SERVICE + The Bus station + The Taxi-hub + The Surface Car parking + The Bicycle & Scooter-parking.

8 points: Kyrgauldy, Otegen Batyr, Suranshy Batyr koshesi, Kuljinsky Trakt, Almalybak, Kyzylkairat, Aksengir, Zhapek Batyr.

The 5C Type of the Node: The Metro Interchange node + The Trolleybus stop + The Taxi-stop + The Surface Car parking + The Bicycle & Scooter Smart-parking.

28 points: Raiymbek Batyr, Zhibek Zholy, Baykonur, Alatay, Rozybakiev koshesi, Sairan, Seifullin dangyly, Zhumabaev koshes, Zhandosov koshesi, Tole Bi koshesi, Aitiyev koshesi, Muratbaev koshesi, Gogol' koshesi, Kuderin koshesi, Dorozhnik, Severnoe Koltso koshesi, Gagarin dangyly, Alekseev koshesi, Kazybaev koshesi, Kulager, Zhas Kanat, Galiley koshesi, Khamidi koshesi, Tatibekov koshesi, Bokeikhanov koshesi, Przhevalsksy koshesi, Ulken Almaty Arnasy.

The 5D Type of the Node: The Metro Interchange node + The Trolleybus stop + The Taxi-hub + The Multi-level Car parking + The Bicycle & Scooter Smart-parking.

6 points: Atakent, Auezov teatry, Kotchin koshesi, Tastak, Kok Bazar, Zaria Wostoka.

The 5E Type of the Node: The Metro Interchange node + The Bus stop + The Taxi-stop + The Surface Car parking + The Bicycle & Scooter-parking.

2 points: Beisembaev koshesi, Esentai.

The 4A Type of the Node: The Bus stop + The Taxi-stop + The Multi-level Car parking + The Bicycle & Scooter-parking.

8 points: Shokai koshesi, Baganashil, Navoi koshesi, Zhurbanov koshesi, Aigerim, Darkhan, Zhansugurov koshesi, Zhulduz.

The 4B Type of the Node: The Bus station + The Taxi-hub + The Surface Car parking + The Bicycle & Scooter-parking.

3 points: Kalkaman, Butakovka, Batysshil Saiabak.

The 4C Type of the Node: The Bus station + The Taxi-hub + The Surface Car parking + The Bicycle & Scooter-parking.

2 points: Baribaev koshesi, Zhandosov koshesi.

The 4D Type of the Node: The Bus station + The Taxi-stop + The Surface Car parking + The Bicycle & Scooter-parking.

3 points: Tau-Samal, Remizovka, Khan-Tengri.

The 4E Type of the Node: The Bus stop + The Taxi-stop + The Surface Car parking + The Bicycle & Scooter-parking.

1 point: Ibragimov koshesi

The 3A Type of the Node: The Trolleybus stop + The Taxi-stop + The Bicycle & Scooter Smart-parking.

27 points: Almaly, Abai, Moskwa, Saryarka, Baumyn Togaiy, Tscherneyshevsky koshesi, Khodjanov koshesi, Ormanov koshesi, Orenburg koshesi, Altynsarin dangyly, Khmelnitsky koshesi, Maiak, Utegen Batyr koshesi, Kairat, Ryskulov dangyly, Kurylysshi, Uljan, Markelov koshesi, Karasai Batyr koshesi, Timiriazev koshesi, Altai, Shemiakin koshesi, Dzhangildin koshesi, Kabanbai Batyr koshesi, Satbaev koshesi, Baikadamov koshesi, Almagul'.

The 3B Type of the Node: The Bus stop + The Taxi-stop + The Bicycle & Scooter-parking.

28 points: Dostyk, Bekmakhanov koshesi, Karasu, Pervomaisky, Zhana-turmys, Akjar, Kamenka,

Almaty koshesi, Mamyr, Almerek, Iliysky Trakt, Abishev koshesi, Baianaul, Guldala, Irgeli, Koksai,

Algabas, Besagash, Tyzdybastau, Belbulak, Birlik, Kok-Kainar, Kokuzek, Boraldai, Baiajanov

koshesi, Ashibulak, Qoyankoz, Ospanov koshesi.

Points of integration of different modes of public and private transport: THE DISTRIBUTION ALONG LINES OF THE METRO are shown in the Table 3.



Points of integration of different modes of public and private transport: THE DISTRIBUTION BY NODE TYPES are shown in the Table 4.

Types of Integration Nodes: THE DISTRIBUTION BY LINES OF THE METRO are shown in the Table 5.

Types of Integration Nodes: THE DISTRIBUTION BY AMOUNT are shown in the Table 6.

Points of integration of different modes of public and private transport: THE POSITION RELATIVE TO THE RING LINE are shown in the Table 7.

Public and private transport Integration nodes types: THE POSITION RELATIVE TO THE RING LINE are shown in the Table 8.

Average values of Integration contacts: THE DISTRIBUTION ALONG LINES OF THE METRO are shown in the Table 9.

Table 3.
 Points of integration of different modes of public and private transport:
 THE DISTRIBUTION ALONG LINES OF THE METRO

Nº/Nº	The Metro Station	The Metro Interchange node	The AIRWAY SERVICE	The RAILWAY SERVICE	The INTERCITY BUS SERVICE	The Bus station	The Bus stop	The Trolleybus station	The Trolleybus stop	The Taxi-hub	The Taxi-stop	The Multi-level Car parking	The Surface Car parking	The Bicycle & Scooter Smart-parking	The Type of the Node	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	<i>The Existing RADIAL LINE</i>	5	0	0	0	0	0	0	7	1	6	1	4	7	0	3
1	Raiymbek Batyr	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
2	Zhibek Zholy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Almaly	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
4	Abai	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
5	Baykonur	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
6	Auezov teatry	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
7	Alatay	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C

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II	<i>The Constructed RADIAL LINE (the Continuation of the Existing Radial Line)</i>	3	0	0	0	0	0	0	4	0	4	0	3	4	0	2	
1	Alatay	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
2	<i>Rozybakiev koshesi</i> (the proposed Station)	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
3	Sairan	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
4	Moskwa	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████ ██████████																	
III	<i>The 1st Planned RADIAL LINE (the Continuation of the Existing Radial Line)</i>	7	0	2	0	1	3	1	6	3	7	2	5	6	4	7	
1	Raiymbek Batyr	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
2	Seifullin dangyly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
3	Kotchin koshesi	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D	
4	Baumnyn Togaiy	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
5	Zhumabaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
6	Tscherny-shevsky koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
7	Wokzal Almaty-1	+	-	+	-	-	+	+	-	+	-	+	-	-	+	7B	

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8	Bekmakhon koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
9	Beisembayev koshesi	+	-	-	-	-	+	-	-	-	+	-	+	-	+	5E	
10	Yntymak	+	-	+	-	+	-	-	-	+	-	-	+	-	+	6B	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
IV	<i>The 2nd Planned RADIAL LINE (the Continuation of the Constructed Radial Line)</i>	1	0	0	0	1	2	1	2	2	3	1	1	2	3	4	
1	Moskwa	-	-	-	-	-	-	+	-	+	-	-	-	+	-	3A	
2	Saryarka	-	-	-	-	-	-	+	-	+	-	-	-	+	-	3A	
3	Zhetysu	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
4	Dostyk	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
5	Kalkaman	-	-	-	-	+	-	-	-	+	-	-	+	-	+	4B	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
V	<i>The 3rd Planned RADIAL LINE</i>	11	0	0	0	0	2	2	13	4	11	4	8	13	2	5	
1	Orbita	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
2	Khodjanov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
3	Zhandosov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
4	Sairan	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
5	Tastak	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D	
6	Tole Bi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
7	Aitiyev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
8	Muratbaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
9	Gogol' koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
10	Zhibek Zholy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
11	Kok Bazar	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D	
12	Baribaev	-	-	-	-	-	-	-	+	-	+	-	+	+	-	4C	

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	koshesi																
13	Ormanov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
14	Orenburg koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
15	Duman	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
VI	<i>The 4th Planned RADIAL LINE</i>	8	0	1	0	1	4	1	5	3	7	2	6	5	5	6	
1	Tole Bi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
2	Kuderin koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
3	Severnoe Koltso koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
4	Zaria Wostoka	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D	
5	Dorozhnik	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
6	Tscheriomushki	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
7	Karasu	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
8	Pervomaisky	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
9	Esentai	+	-	-	-	-	+	-	-	-	+	-	+	-	+	5E	
10	Yntymak	+	-	+	-	+	-	-	-	+	-	-	+	-	+	6B	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
VII	<i>The Proposed RING RED LINE</i>	18	1	1	0	0	26	18	0	18	8	26	0	0	26	4	
1	Almaty-Auezhai	+	+	-	-	-	+	+	-	+	-	+	-	-	+	7A	
2	Tereshkova koshesi	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
3	Atyray	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
4	Duman	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
5	Shokai koshesi	-	-	-	-	-	+	-	-	-	+	+	-	-	+	4A	
6	Koktobe	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
7	Gornyi Gigant	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
8	Tramplin	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
9	Baganashil	-	-	-	-	-	+	-	-	-	+	+	-	-	+	4A	
10	Kazakhfilm	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	

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	koshesi																		
14	Alekseev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
15	Kazybaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
16	Kulager	+	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
17	Zhumabaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
18	Khmelnitsky koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
19	Zhas Kanat	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			
20	Maiak	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
21	Almaty Auezhai	+	+	-	-	-	+	+	-	+	-	+	-	-	+	7A			
22	Almerek	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B			
23	Iliysky Trakt	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B			
24	Otegen Batyr	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B			
IX	<i>The Proposed RADIAL BLUE LINE</i>	10	0	1	2	2	6	2	10	6	12	4	9	10	8	8			
1	Suranshy Batyr koshesi	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B			
2	Abishev koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B			
3	Baianaul	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B			
4	Aksai	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C			
5	Utegen Batyr koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
6	Tastak	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D			
7	Kuderin koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			
8	Galiley koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			
9	Alekseyev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			
10	Wokzal Almaty-2	+	-	+	-	-	-	-	+	+	-	+	-	+	-	6A			
11	Raiymbek Batyr	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			
12	Khamidi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			
13	Tatibekov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C			

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14	Kairat	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	3A
15	Tereshkova koshesi	+	-	-	-	-	+	+	-	+	-	+	-	-	-	+	6C
16	Guldala	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
17	Kuljinsky Trakt	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B	
18	Ibragimov koshesi	-	-	-	-	-	+	-	-	-	+	-	+	-	+	4E	
<hr/>																	
X	<i>The Proposed RADIAL ORANGE LINE</i>	9	0	0	2	2	9	2	9	5	15	3	8	9	11	6	
1	Almalybak	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B	
2	Irgeli	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
3	Koksaï	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
4	Algabas	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
5	Akulak	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
6	Ryskulov dangly	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
7	Kurylysshi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
8	Severnoe Koltso koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
9	Bokeikhan-nov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
10	Kazybaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
11	Przheval-sky koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
12	Kotchin koshesi	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D	
13	Ulken Almaty Arnasy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
14	Tatibekov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C	
15	Atyray	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
16	Besagash	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
17	Tyzdybas-tau	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
18	Belbulak	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
19	Birlik	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
20	Kyzylkairat	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B	
<hr/>																	

XI	<i>The Proposed RADIAL BROWN LINE</i>	8	0	0	0	2	3	2	8	5	8	4	6	8	5	7
1	Batysshil Saiabak	-	-	-	-	+	-	-	-	+	-	-	+	-	+	4B
2	Kok-Kainar	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B
3	Shanyrak	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
4	Uljan	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
5	Zaria Wostoka	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
6	Markelov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
7	Bokeikhanov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
8	Galiley koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
9	Aitiyev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
10	Alatay	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
11	Atakent	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
12	Tramplin	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
13	Remizovka	-	-	-	-	+	-	-	-	-	+	-	+	-	+	4D
<hr/>																
XII	<i>The Proposed RADIAL YELLOW LINE</i>	9	1	1	1	2	6	2	9	5	12	3	9	9	8	8
1	Aksengir	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
2	Kokuzek	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B
3	Boral dai	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B
4	Boral dai-Auezhai	-	+	-	-	-	+	-	-	+	-	-	+	-	+	5A
5	Uzhet	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
6	Dorozhnik	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
7	Kulager	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
8	Przhevalsky koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
9	Seifullin dangly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
10	Wokzal Almaty-2	+	-	+	-	-	-	-	+	+	-	+	-	+	-	6A
11	Gogol' koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
12	Karasai Batyr koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A

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XIV	<i>The Proposed RADIAL GREY LINE</i>	4	0	0	0	1	1	1	5	1	6	1	4	5	2	4
1	Tole Bi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
2	Rozybakiev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Gagarin dangly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
4	Baikadamov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
5	Almagul'	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
6	Kazakhfilm	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
7	Khan-Tengri	-	-	-	-	+	-	-	-	-	+	-	+	-	+	4D
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Table 4.
 Points of integration of different modes of public and private transport:
 THE DISTRIBUTION BY NODE TYPES

Nº/Nº	The Metro Station	The Metro Interchange node	The AIRWAY SERVICE	The RAILWAY SERVICE	The INTERCITY BUS SERVICE	The Bus station	The Bus stop	The Trolleybus station	The Trolleybus stop	The Taxi-hub	The Taxi-stop	The Multi-level Car parking	The Surface Car parking	The Bicycle & Scooter Smart-parking	The Bicycle & Scooter-parking	The Type of the Node
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Almaty Auezhai	+ + - - - + + - + - + - + - +														7A
1	Wokzal Almaty-1	+ - + - - + + - + - + - + - +														7B

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1	Wokzal Almaty-2	+	-	+	-	-	-	-	+	+	-	+	-	+	-	6A
1	Yntymak	+	-	+	-	+	-	-	-	+	-	-	+	-	+	6B
1	Zhetysu	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
2	Orbita	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
3	Duman	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
4	Tscherio- mushki	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
5	Atyray	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
6	Akulak	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
7	Koktobe	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
8	Krasno- gvardeisky Trakt	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
9	Tereshkova koshesi	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
10	Aksai	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
11	Gornyi Gigant	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
12	Uzhet	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
13	Tramplin	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C

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14	Shanyrak	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
15	Kazakhfilm	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
16	Taugul'	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C
1	Boraldai-Auezhai	-	+	-	-	-	+	-	-	+	-	-	+	-	+	5A
1	Kyrgauldy	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
2	Otegen Batyr	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
3	Suranshy Batyr koshesi	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
4	Kuljinsky Trakt	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
5	Almalybak	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
6	Kyzylkairat	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
7	Aksengir	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
8	Zhapek Batyr	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
1	Raiymbek Batyr	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
2	Zhibek Zholy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Baykonur	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
4	Alatay	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C

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5	Rozybakiev koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
6	Sairan	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
7	Seifullin dangyly	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
8	Zhumabaev koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
9	Zhandosov koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
10	Tole Bi koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
11	Aitiyev koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
12	Muratbaev koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
13	Gogol' koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
14	Kuderin koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
15	Dorozhnik	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		
16	Severnoe Koltso koshesi	+	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	5C		

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17	Gagarin dangly		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
18	Alekseev koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
19	Kazybaev koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
20	Kulager		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
21	Zhas Kanat		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
22	Galiley koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
23	Khamidi koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
24	Tatibekov koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
25	Bokeikha- nov koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
26	Przheval- sky koshesi		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
27	Ulken Almaty Arnasy		+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	5C				
1	Auezov teatry		+	-	-	-	-	-	-	-	+	+	-	+	-	+	-	+	-	5D					

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2	Butakovka	-	-	-	-	+	-	-	-	+	-	-	+	-	+	4B
3	Batysshil Saibak	-	-	-	-	+	-	-	-	+	-	-	+	-	+	4B
1	Baribaev koshesi	-	-	-	-	-	-	-	+	-	+	-	+	+	-	4C
1	Tau-Samal	-	-	-	-	+	-	-	-	+	-	+	-	+	-	4D
2	Remizovka	-	-	-	-	+	-	-	-	+	-	+	-	+	-	4D
3	Khan- Tengri	-	-	-	-	+	-	-	-	+	-	+	-	+	-	4D
1	Ibragimov koshesi	-	-	-	-	-	+	-	-	+	-	+	-	+	-	4E
1	Almaly	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
2	Abai	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
3	Moskwa	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
4	Saryarka	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
5	Baumny Togaiy	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
6	Tscherny- shevsky koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
7	Khodjanov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
8	Ormanov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
9	Orenburg koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
10	Altynsarın dangyly	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
11	Khmel- nitsky	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A

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2	Bekma-khanov koshesi	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
3	Karasu	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
4	Pervo-maisky	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
5	Zhana-turmys	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
6	Akjar	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
7	Kamenka	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
8	Almaty koshesi	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
9	Mamyr	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
10	Almerek	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
11	Iliysky Trakt	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
12	Abishev koshesi	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
13	Baianaul	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
14	Guldala	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
15	Irgeli	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
16	Koksai	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
17	Algabas	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
18	Besagash	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
19	Tyzdybas-tau	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
20	Belbulak	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			
21	Birlik	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	3B			

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Table 5.
Types of Integration Nodes: THE DISTRIBUTION BY LINES OF THE METRO

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	<i>Radial Line)</i>															
1	Wokzal Almaty-1	+	-	+	-	-	+	+	-	+	-	+	-	-	+	7B
VII	<i>The Proposed RING RED LINE</i>	2	1	1	0	0	2	2	0	2	0	2	0	0	2	2
1	Almaty- Auezhai	+	+	-	-	-	+	+	-	+	-	+	-	-	+	7A
2	Wokzal Almaty-1	+	-	+	-	-	+	+	-	+	-	+	-	-	+	7B
VIII	<i>The Proposed RADIAL GREEN LINE</i>	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1
1	Almaty Auezhai	+	+	-	-	-	+	+	-	+	-	+	-	-	+	7A
The Integration Node Type 6 (A, B, C)																
III	<i>The Planned RADIAL LINE (the Continuation of the Existing Radial Line)</i>	1	0	1	0	1	0	0	0	1	0	0	1	0	1	1
1	Yntymak	+	-	+	-	+	-	-	-	+	-	-	+	-	+	6B
IV	<i>The Planned RADIAL</i>	1	0	0	0	0	1	1	0	1	0	1	0	0	1	1

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	<i>LINE (the Continuation of the Constructed Radial Line)</i>																
1	Zhetysu	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
V	<i>The Planned RADIAL LINE</i>	2	0	0	0	0	2	2	0	2	0	2	0	0	2	2	
1	Orbita	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
2	Duman	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
VI	<i>The Planned RADIAL LINE</i>	2	0	1	0	1	1	1	0	2	0	1	1	0	2	2	
1	Tscheriomushki	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
2	Yntymak	+	-	+	-	+	-	-	-	+	-	-	+	-	+	6B	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
VII	<i>The Proposed RING RED LINE</i>	16	0	0	0	0	16	16	0	16	0	16	0	0	16	1	
1	Tereshkova koshesi	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
2	Atyray	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
3	Duman	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
4	Koktobe	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
5	Gornyi Gigant	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
6	Tramplin	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
7	Kazakhfilm	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
8	Orbita	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
9	Taugul'	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
10	Zhetysu	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
11	Aksai	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
12	Akulak	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
13	Shanyrak	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
14	Uzhet	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
15	Tscheriomushki	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
16	Krasno-gvardeisky Trakt	+	-	-	-	-	+	+	-	+	-	+	-	-	+	6C	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

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	<i>LINE</i>																			
1	Krasno-gvardeisky Trakt	+	-	-	-	-	+	+	-	+	-	+	-	-	-	+	-	6C		
2	Koktobe	+	-	-	-	-	+	+	-	+	-	+	-	-	-	+	-	6C		
XIV	<i>The Proposed RADIAL GREY LINE</i>	1	0	0	0	0	1	1	0	1	0	1	0	0	1	1				
1	Kazakhfilm	+	-	-	-	-	+	+	-	+	-	+	-	-	+	-	6C			
The Integration Node Type 5 (A, B, C, D, E)																				
I	<i>The Existing RADIAL LINE</i>	5	0	0	0	0	0	0	5	1	4	1	4	5	0	2				
1	Raiymbek Batyr	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C				
2	Zhibek Zholy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C				
3	Baykonur	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C				
4	Auezov teatry	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D				
5	Alatay	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C				
II	<i>The Constructed RADIAL LINE (the Continuation of the Existing Radial Line)</i>	3	0	0	0	0	0	0	3	0	3	0	3	3	0	1				
1	Alatay	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C				

2	Rozybakiev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Sairan	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
III	<i>The Planned RADIAL LINE (the Continuation of the Existing Radial Line)</i>	5	0	0	0	0	1	0	4	1	4	1	4	4	1	3
1	Raiymbek Batyr	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
2	Seifullin dangly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Kotchin koshesi	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
4	Zhumabaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
5	Beisembayev koshesi	+	-	-	-	-	+	-	-	-	+	-	+	-	+	5E
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
V	<i>The Planned RADIAL LINE</i>	9	0	0	0	0	0	0	9	2	7	2	7	9	0	2
1	Zhandosov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
2	Sairan	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Tastak	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
4	Tole Bi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
5	Aitiyev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
6	Muratbaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
7	Gogol' koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
8	Zhibek Zholy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
9	Kok Bazar	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
VI	<i>The Planned RADIAL LINE</i>	6	0	0	0	0	1	0	5	1	5	1	5	5	1	3
1	Tole Bi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C

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2	Kuderin koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Severnoe Koltso koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
4	Zaria Wostoka	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
5	Dorozhnik	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
6	Esentai	+	-	-	-	-	+	-	-	-	+	-	+	-	+	5E
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
VIII	<i>The Proposed RADIAL GREEN LINE</i>	9	0	0	2	2	0	0	9	2	8	1	10	9	2	3
1	Kyrgauldy	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
2	Zhandosov koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Gagarin dangly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
4	Atakent	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
5	Auezov Teatry	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
6	Muratbaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
7	Alekseev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
8	Kazybaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
9	Kulager	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
10	Zhumabaev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
11	Zhas Kanat	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
12	Otegen Batyr	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
IX	<i>The Proposed RADIAL BLUE LINE</i>	7	0	0	2	2	0	0	7	3	6	1	7	7	2	3
1	Suranshy Batyr koshesi	-	-	-	+	+	-	-	-	+	-	-	+	-	+	5B
2	Tastak	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
3	Kuderin koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
4	Galiley koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C

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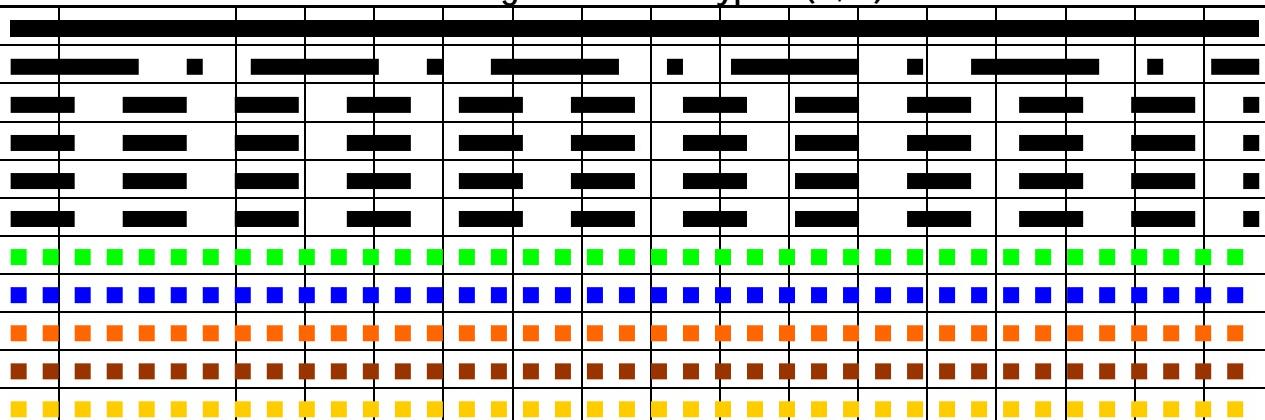
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6	Atakent	+	-	-	-	-	-	-	+	+	-	+	-	+	-	5D
XII	<i>The Proposed RADIAL YELLOW LINE</i>	6	1	0	1	1	1	0	6	2	6	0	8	6	2	3
1	Aksengir	-	-	-	+	+	-	-	+	-	-	+	-	+	-	5B
2	Boraldai-Auezhai	-	+	-	-	-	+	-	-	+	-	-	+	-	+	5A
3	Dorozhnik	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
4	Kulager	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
5	Przhevalsky koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
6	Seifullin dangyly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
7	Gogol' koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
8	Baykonur	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
XIII	<i>The Proposed RADIAL CELADON LINE</i>	6	0	0	1	1	2	0	4	2	5	1	6	4	3	4
1	Zhapek Batyr	-	-	-	+	+	-	-	+	-	-	+	-	+	-	5B
2	Esentai	+	-	-	-	-	+	-	-	-	+	-	+	-	+	5E
3	Beisembaev koshesi	+	-	-	-	-	+	-	-	-	+	-	+	-	+	5E
4	Zhas Kanat	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
5	Ulken Almaty Arnasy	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
6	Khamidi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
7	Kok Bazar	+	-	-	-	-	-	-	+	+	-	-	+	-	+	5D
XIV	<i>The Proposed RADIAL GREY LINE</i>	3	0	0	0	0	0	0	3	0	3	0	3	3	0	1
1	Tole Bi koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
2	Rozybakiev koshesi	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C
3	Gagarin dangyly	+	-	-	-	-	-	-	+	-	+	-	+	+	-	5C

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	<i>RADIAL BLUE LINE</i>																			
1	Ibragimov koshesi	-	-	-	-	-	+	-	-	-	+	-	+	-	+	4E				
XI	<i>The Proposed RADIAL BROWN LINE</i>	0	0	0	0	2	0	0	0	1	1	0	2	0	2	2				
1	Batysshil Saiabak	-	-	-	-	+	-	-	-	+	-	-	+	-	+	4B				
2	Remizovka	-	-	-	-	+	-	-	-	-	+	-	+	-	+	4D				
XII	<i>The Proposed RADIAL YELLOW LINE</i>	0	0	0	0	1	0	0	0	0	1	0	1	0	1	1				
1	Tau-Samal	-	-	-	-	+	-	-	-	-	+	-	+	-	+	4D				
XIII	<i>The Proposed RADIAL CELADON LINE</i>	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1				
1	Butakovka	-	-	-	-	+	-	-	-	+	-	-	+	-	+	4B				
XIV	<i>The Proposed RADIAL GREY LINE</i>	0	0	0	0	1	0	0	0	0	1	0	1	0	1	1				
1	Khan-Tengri	-	-	-	-	+	-	-	-	-	+	-	+	-	+	4D				
The Integration Node Type 3 (A, B)																				
																				

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I	<i>The Existing RADIAL LINE</i>	0	0	0	0	0	0	0	2	0	2	0	0	2	0	1			
1	Almaly	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
2	Abai	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
II	<i>The Constructed RADIAL LINE (the Continuation of the Existing Radial Line)</i>	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1			
1	Moskwa	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
III	<i>The Planned RADIAL LINE (the Continuation of the Existing Radial Line)</i>	0	0	0	0	0	1	0	1	0	2	0	0	1	1	2			
1	Baumnyn Togaiy	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
2	Tscherny-shhevsky koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
3	Bekmakhan-nov koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B			
IV	<i>The Planned RADIAL LINE (the Continuation of the Constructed Radial Line)</i>	0	0	0	0	0	1	1	2	0	3	0	0	2	1	2			
1	Moskwa	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
2	Saryarka	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A			
3	Dostyk	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B			
V	<i>The Planned</i>	0	0	0	0	0	0	0	3	0	3	0	0	3	0	1			

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	<i>RADIAL LINE</i>																
1	Khodjanov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
2	Ormanov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
3	Orenburg koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
VI	<i>The Planned RADIAL LINE</i>	0	0	0	0	0	2	0	0	0	2	0	0	0	2	1	
1	Karasu	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
2	Pervomaisky	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
VIII	<i>The Proposed RADIAL GREEN LINE</i>	0	0	0	0	0	7	0	3	0	10	0	0	3	7	2	
1	Zhanatur-mys	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
2	Akjar	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
3	Kamenka	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
4	Almaty koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
5	Mamyr	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
6	Altynsarin dangly	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
7	Khmelnitsky koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
8	Maiak	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
9	Almerek	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
10	Iliysky Trakt	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
IX	<i>The Proposed RADIAL BLUE LINE</i>	0	0	0	0	0	3	0	2	0	5	0	0	2	3	2	
1	Abishev koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
2	Baianaul	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B	
3	Utegen Batyr koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
4	Kairat	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	

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5	Guldala	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
	The Proposed RADIAL ORANGE LINE	0	0	0	0	0	7	0	2	0	9	0	0	2	7	2	
1	Irgeli	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
2	Koksaï	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
3	Algabas	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
4	Ryskulov dangly	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	3A
5	Kurylysshi	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	3A
6	Besagash	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
6	Tyzdybas-tau	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
7	Belbulak	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
8	Birlik	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
	The Proposed RADIAL BROWN LINE	0	0	0	0	0	1	0	2	0	3	0	0	2	1	2	
1	Kok-Kainar	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
2	Uljan	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	3A
3	Merkelov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
	The Proposed RADIAL YELLOW LINE	0	0	0	0	0	3	0	2	0	5	0	0	2	3	2	
1	Kokuzek	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
2	Boraldai	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
3	Karasai Batyr koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
4	Timiriazev koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A	
5	Baiajanov koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	3B
	The Proposed RADIAL CELADON LINE	0	0	0	0	0	3	0	5	0	8	0	0	5	3	2	

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1	Ashibulak	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B
2	Qoyankoz	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B
3	Altai	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
4	Shemiakin koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
5	Dzhangildin koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
6	Kabanbai Batyr koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
7	Satbaev koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
8	Ospanov koshesi	-	-	-	-	-	+	-	-	-	+	-	-	-	+	3B
XIV																
	<i>The Proposed RADIAL GREY LINE</i>	0	0	0	0	0	0	0	2	0	2	0	0	2	0	1
1	Baikadamov koshesi	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
2	Almagul'	-	-	-	-	-	-	-	+	-	+	-	-	+	-	3A
1																
2																
3																
4																
5																
6																
7																
8																

Table 6.
 Types of Integration Nodes: THE DISTRIBUTION BY AMOUNT

Nº/Nº	Amount of Metro lines and Metro stations	The Metro Interchange node	The AIRWAY SERVICE	The RAILWAY SERVICE	The INTERCITY BUS SERVICE	The Bus station	The Bus stop	The Trolleybus station	The Trolleybus stop	The Taxi-hub	The Taxi-stop	The Multi-level Car parking	The Surface Car parking	The Bicycle & Scooter Smart-parking	The Bicycle & Scooter-parking	The Type of the Node
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1 Station 2 Lines	+	+	-	-	-	+	+	-	+	-	+	-	-	+	7A
1																
2																
3																
4																
5																
6																
7																

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Table 7.
Points of integration of different modes of public and private transport:
THE POSITION RELATIVE TO THE RING LINE

Nº №	The Position relative to the Ring Line	The Metro Interchange node	The AIRWAY SERVICE	The RAILWAY SERVICE	The INTERCITY BUS SERVICE	The Bus station	The Bus stop	The Trolleybus station	The Trolleybus stop	The Taxi-hub	The Taxi-stop	The Multi-level Car parking	The Surface Car parking	The Bicycle & Scooter Smart-parking	The Bicycle & Scooter-parking	The Type of the Node
1	Inside the Ring Line	34	0	1	0	0	0	62	7	55	7	28	62	0	5	
	On the Ring Line	18	1	1	0	0	26	18	0	18	8	26	0	0	26	4

	Outside the Ring Line	3	1	1	8	15	31	0	0	13	33	0	19	0	46	8
	IN TOTAL	55	2	3	8	15	57	18	62	38	96	33	47	62	72	17
¹		²	³	⁴	⁵	⁶	⁷	⁸	⁹	¹⁰	¹¹	¹²	¹³	¹⁴	¹⁵	¹⁶

Table 8.
 Public and private transport Integration nodes types: THE POSITION RELATIVE TO THE RING LINE

Nº	The Type of the Node	Points Inside the Ring Line	Points On the Ring Line	Points Outside the Ring Line	IN TOTAL
1	2	3	4	5	6
1	7A	-	1	-	1
2	7B	-	1	-	1
3	6A	1	-	-	1
4	6B	-	-	1	1
5	6C	-	16	-	16
6	5A	-	-	1	1
7	5B	-	-	8	8
8	5C	27	-	-	27
9	5D	6	-	-	6
10	5E	-	-	2	2
11	4A	-	8	-	8
12	4B	-	-	3	3
13	4C	1	-	-	1
14	4D	-	-	3	3
15	4E	-	-	1	1
16	3A	27	-	-	27
17	3B	-	-	28	28
	IN TOTAL (points)	62	26	47	135
	IN TOTAL (types of nodes)	5	4	8	17
¹	²	³	⁴	⁵	⁶

Table 9.
 Average values of Integration contacts: THE DISTRIBUTION ALONG LINES OF THE METRO

Nº	The Metro lines	The average number of contact modes MODES / STATIONS	The average number of contacts CONTACTS / STATIONS	The average number of node types TYPES / STATIONS
1	2	3	4	5
I	The Existing RADIAL LINE	1,00	4,23	0,43
II	The Constructed RADIAL LINE (the Continuation of the Existing Radial Line)	1,25	4,50	0,50
III	The 1 st Planned RADIAL LINE (the Continuation of the Existing Radial Line)	1,20	4,70	0,70
IV	The 2 nd Planned RADIAL LINE (the Continuation of the Constructed Radial Line)	2,20	3,80	0,80
V	The 3 rd Planned RADIAL LINE	0,67	4,67	0,33
VI	The 4 th Planned RADIAL LINE	0,70	4,80	0,60
VII	The Proposed RING RED LINE	0,35	5,46	0,15
VIII	The Proposed RADIAL GREEN LINE	0,54	4,25	0,29
IX	The Proposed RADIAL BLUE LINE	0,72	4,56	0,44
X	The Proposed RADIAL ORANGE LINE	0,60	4,10	0,30
XI	The Proposed RADIAL BROWN LINE	0,85	4,54	0,54
XII	The Proposed RADIAL YELLOW LINE	0,22	4,53	0,47
XIII	The Proposed RADIAL CELADON LINE	0,67	4,17	0,44
XIV	The Proposed RADIAL GREY LINE	1,57	4,29	0,57
1	2	3	4	5

Lines have the following integration contact values:

The Existing RADIAL LINE – 7 modes of integration contacts (The METRO INTERCHANGE NODE – 5, The TROLLEYBUS STOP – 7, The TAXI-HUB – 1, The TAXI-STOP – 6, The MULTI-LEVEL CAR PARKING – 1, The SURFACE CAR PARKING – 4, The BICYCLE & SCOOTER SMART-PARKING – 7); 3 types of nodes (5C – 4, 5D – 1, 3A - 2).

The average number of contact modes 1 (7 modes / 7 stations); the average number of contacts 4,23 (31 contacts / 7 stations); the average number of node types 0,43 (3 types / 7 stations).

The Constructed RADIAL LINE (the Continuation of the Existing Radial Line) – 5 modes of integration contacts (The METRO INTERCHANGE NODE – 3, The TROLLEYBUS STOP – 4, The TAXI-STOP – 4, The SURFACE CAR PARKING – 3, The BICYCLE & SCOOTER SMART-PARKING – 4); 2 types of nodes (5C – 3, 3A - 1).

The average number of contact modes 1,25 (5 modes / 4 stations); the average number of contacts 4,50 (18 contacts / 4 stations); the average number of node types 0,50 (2 types / 4 stations).

The 1st Planned RADIAL LINE (the Continuation of the Existing Radial Line) – 12 modes of integration contacts (The METRO INTERCHANGE NODE – 7, The RAILWAY SERVICE – 2, The BUS STATION – 1, The BUS STOP – 3, The TROLLEYBUS STATION – 1, The TROLLEYBUS STOP – 6, The

TAXI-HUB – 3, The TAXI-STOP – 7, The MULTI-LEVEL CAR PARKING – 2, The SURFACE CAR PARKING – 5, The BICYCLE & SCOOTER SMART-PARKING – 6, The BICYCLE & SCOOTER-PARKING – 4); 7 types of nodes (7B – 1, 6B – 1, 5C – 3, 5D – 1, 5E – 1, 3A – 2, 3B - 1).

The average number of contact modes 1,2 (12 modes / 10 stations); the average number of contacts 4,70 (47 contacts / 10 stations); the average number of node types 0,70 (7 types / 10 stations).

The 2nd Planned RADIAL LINE (the Continuation of the Constructed Radial Line) – 11 modes of integration contacts (The METRO INTERCHANGE NODE – 1, The BUS STATION – 1, The BUS STOP – 2, The TROLLEYBUS STATION – 1, The TROLLEYBUS STOP – 2, The TAXI-HUB – 2, The TAXI-STOP – 3, The MULTI-LEVEL CAR PARKING – 1, The SURFACE CAR PARKING – 1, The BICYCLE & SCOOTER SMART-PARKING – 2, The BICYCLE & SCOOTER-PARKING - 3), 4 types of nodes (6C – 1, 4B – 1, 3A – 2, 3B – 1).

The average number of contact modes 2,2 (11 modes / 5 stations); the average number of contacts 3,80 (19 contacts / 5 stations); the average number of node types 0,80 (4 types / 5 stations).

The 3rd Planned RADIAL LINE – 10 modes of integration contacts (The METRO INTERCHANGE NODE – 11, The BUS STOP – 2, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 13, The TAXI-HUB – 4, The TAXI-STOP – 11, The MULTI-LEVEL CAR PARKING – 4, The SURFACE CAR PARKING – 8, The BICYCLE & SCOOTER SMART-PARKING – 13, The BICYCLE & SCOOTER-PARKING – 2), 5 types of nodes (6C – 2, 5C – 7, 5D – 2, 4C – 1, 3A - 3).

The average number of contact modes 0,67 (10 modes / 15 stations); the average number of contacts 4,67 (70 contacts / 15 stations); the average number of node types 0,33 (5 types / 15 stations).

The 4th Planned RADIAL LINE – 12 modes of integration contacts (The METRO INTERCHANGE NODE – 8, The RAILWAY SERVICE – 1, The BUS STATION – 1, The BUS STOP – 4, The TROLLEYBUS STATION – 1, The TROLLEYBUS STOP – 5, The TAXI-HUB – 3, The TAXI-STOP – 7, The MULTI-LEVEL CAR PARKING – 2, The SURFACE CAR PARKING – 6, The BICYCLE & SCOOTER SMART-PARKING – 5, The BICYCLE & SCOOTER-PARKING – 5), 6 types of nodes (6B – 1, 6C – 1, 5C – 4, 5D – 1, 5E – 1, 3B - 2).

The average number of contact modes 0,70 (7 modes / 10 stations); the average number of contacts 4,80 (48 contacts / 10 stations); the average number of node types 0,60 (6 types / 10 stations).

The Proposed RING RED LINE – 9 modes of integration contacts (The METRO INTERCHANGE NODE – 18, The AIRWAY SERVICE – 1, The RAILWAY SERVICE – 1, The BUS STOP – 26, The TROLLEYBUS STATION – 18, The TAXI-HUB – 18, The TAXI-STOP – 8, The MULTI-LEVEL CAR PARKING – 26, The BICYCLE & SCOOTER-PARKING - 26), 4 types of nodes (7A – 1, 7B – 1, 6C – 16, 4A – 8).

The average number of contact modes 0,35 (9 modes / 26 stations); the average number of contacts 5,46 (142 contacts / 26 stations); the average number of node types 0,15 (4 types / 26 stations).

The Proposed RADIAL GREEN LINE – 13 modes of integration contacts (The METRO INTERCHANGE NODE – 11, The AIRWAY SERVICE – 1, The INTERCITY BUS SERVICE – 2, The BUS STATION – 2, The BUS STOP – 9, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 13, The TAXI-HUB – 6, The TAXI-STOP – 18, The MULTI-LEVEL CAR PARKING – 4, The SURFACE CAR PARKING – 10, The BICYCLE & SCOOTER SMART-PARKING – 13, The BICYCLE & SCOOTER-PARKING - 11), 7 types of nodes (7A – 1, 6C – 1, 5B – 2, 5C – 8, 5D – 2, 3A – 3, 3B – 7).

The average number of contact modes 0,54 (13 modes / 24 stations); the average number of contacts 4,25 (102 contacts / 24 stations); the average number of node types 0,29 (7 types / 24 stations).

The Proposed RADIAL BLUE LINE – 13 modes of integration contacts (The METRO INTERCHANGE NODE – 10, The RAILWAY SERVICE – 1, The INTERCITY BUS SERVICE – 2, The BUS STATION – 2, The BUS STOP – 6, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 10, The TAXI-HUB – 6, The TAXI-STOP – 12, The MULTI-LEVEL CAR PARKING – 4, The SURFACE CAR

PARKING – 9, The BICYCLE & SCOOTER SMART-PARKING – 10, The BICYCLE & SCOOTER-PARKING – 8), 8 types of nodes (6A – 1, 6C – 2, 5B – 2, 5C – 6, 5D – 1, 4E – 1, 3A – 2, 3B – 3).

The average number of contact modes 0,72 (13 modes / 18 stations); the average number of contacts 4,56 (82 contacts / 18 stations); the average number of node types 0,44 (8 types / 18 stations).

The Proposed RADIAL ORANGE LINE – 12 modes of integration contacts (The METRO INTERCHANGE NODE – 9, The INTERCITY BUS SERVICE – 2, The BUS STATION – 2, The BUS STOP – 9, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 9, The TAXI-HUB – 5, The TAXI-STOP – 15, The MULTI-LEVEL CAR PARKING – 3, The SURFACE CAR PARKING – 8, The BICYCLE & SCOOTER SMART-PARKING – 9, The BICYCLE & SCOOTER-PARKING – 11), 6 types of nodes (6C – 2, 5B – 2, 5C – 6, 5D – 1, 3A – 2, 3B – 7).

The average number of contact modes 0,60 (12 modes / 20 stations); the average number of contacts 4,10 (82 contacts / 20 stations); the average number of node types 0,30 (6 types / 20 stations).

The Proposed RADIAL BROWN LINE – 11 modes of integration contacts (The METRO INTERCHANGE NODE – 8, The BUS STATION – 2, The BUS STOP – 3, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 8, The TAXI-HUB – 5, The TAXI-STOP – 8, The MULTI-LEVEL CAR PARKING – 4, The SURFACE CAR PARKING – 6, The BICYCLE & SCOOTER SMART-PARKING – 8, The BICYCLE & SCOOTER-PARKING – 5), 8 types of nodes (6C – 2, 5C – 4, 5D – 2, 4B – 1, 4D – 1, 3A – 2, 3B – 1).

The average number of contact modes 0,85 (11 modes / 13 stations); the average number of contacts 4,54 (59 contacts / 13 stations); the average number of node types 0,54 (7 types / 13 stations).

The Proposed RADIAL YELLOW LINE – 14 modes of integration contacts (The METRO INTERCHANGE NODE – 9, The AIRWAY SERVICE – 1, The RAILWAY SERVICE – 1, The INTERCITY BUS SERVICE – 1, The BUS STATION – 2, The BUS STOP – 6, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 9, The TAXI-HUB – 5, The TAXI-STOP – 12, The MULTI-LEVEL CAR PARKING – 3, The SURFACE CAR PARKING – 9, The BICYCLE & SCOOTER SMART-PARKING – 9, The BICYCLE & SCOOTER-PARKING – 8), 8 types of nodes (6A – 1, 6C – 2, 5A – 1, 5B – 1, 5C – 6, 4D – 1, 3A – 2, 3B – 3).

The average number of contact modes 0,22 (14 modes / 17 stations); the average number of contacts 4,53 (77 contacts / 17 stations); the average number of node types 0,47 (8 types / 17 stations).

The Proposed RADIAL CELADON LINE – 12 modes of integration contacts (The METRO INTERCHANGE NODE – 8, The INTERCITY BUS SERVICE – 1, The BUS STATION – 2, The BUS STOP – 7, The TROLLEYBUS STATION – 2, The TROLLEYBUS STOP – 9, The TAXI-HUB – 5, The TAXI-STOP – 13, The MULTI-LEVEL CAR PARKING – 3, The SURFACE CAR PARKING – 7, The BICYCLE & SCOOTER SMART-PARKING – 9, The BICYCLE & SCOOTER-PARKING – 9), 8 types of nodes (6C – 2, 5B – 1, 5C – 3, 5D – 1, 5E – 2, 4B – 1, 3A – 5, 3B – 3).

The average number of contact modes 0,67 (12 modes / 18 stations); the average number of contacts 4,17 (75 contacts / 18 stations); the average number of node types 0,44 (8 types / 18 stations).

The Proposed RADIAL GREY LINE – 11 modes of integration contacts (The METRO INTERCHANGE NODE – 4, The BUS STATION – 1, The BUS STOP – 1, The TROLLEYBUS STATION – 1, The TROLLEYBUS STOP – 5, The TAXI-HUB – 1, The TAXI-STOP – 6, The MULTI-LEVEL CAR PARKING – 1, The SURFACE CAR PARKING – 4, The BICYCLE & SCOOTER SMART-PARKING – 5, The BICYCLE & SCOOTER-PARKING – 2), 4 types of nodes (6C – 2, 5C – 3, 4D – 1, 3A – 2).

The average number of contact modes 1,57 (11 modes / 7 stations); the average number of contacts 4,29 (31 contacts / 7 stations); the average number of node types 0,57 (4 types / 7 stations).

The average number of integration contact modes (MODES / STATIONS) is in the range 0,22 (The Proposed RADIAL YELLOW LINE) – 2,20 (The 2nd Planned RADIAL LINE – the Continuation of the Constructed Radial Line).

The average number of integration contacts (CONTACTS / STATIONS) is in the range 3,80 (The 2nd Planned RADIAL LINE – the Continuation of the Constructed Radial Line) – 5,46 (The Proposed RING RED LINE).

The average number of integration node types (TYPES / STATIONS) is in the range 0,15 (The Proposed RING RED LINE) – 0,80 (The 2nd Planned RADIAL LINE – the Continuation of the Constructed Radial Line).

Number of integration contacts: Inside the Ring Line – 62; On the Ring Line – 26; Outside the Ring Line – 47; IN TOTAL – 165.

Conclusions of the Second Chapter

Held in the Second chapter analysis led to following conclusions:

1. The developed Metro network can serve as a basis for an Integrated Public Transport System. It allows you to combine of external and internal urban transport (public and private), providing a convenient transferring from one mode to another.
2. The External Public transport is represented by three types: the Air transportation (two airports), the Rail transportation (two conventional railway terminals, one high-speed railway terminal), the Bus Transportation (eight bus terminals). At all these points are located Metro stations.
3. The Internal Public transport is represented by three types: the Bus service, the Trolleybus service, the Taxi service. At each Metro station there is a Taxi hub/a Taxi stop, a Bus station/a Bus stop (the Ring line, outer portions of radial lines) or a Trolleybus station/a Trolleybus stop (the Ring line, the inner portion of radial lines).
4. The Private transport is represented by three main types: cars, bicycles and scooters. At each Metro station there is a Surface car parking/a Multi-level car parking and a Bicycle & Scooter Smart-parking/a Bicycle & Scooter open parking.
5. Integrated points – Metro stations – are represented by five types with seventeen subtypes. There are different combinations of transport contacts: the Metro Interchange node, the Airway service, the Railway service, the intercity Bus service, the Bus station, the Bus stop, the Trolleybus station, the Trolleybus stop, the Taxi-hub, the Taxi-stop, the Multi-level Car parking, the Surface Car parking, the Bicycle & Scooter Smart-parking, the Bicycle & Scooter-parking. Maximum numbers of contacts – 7, minimum numbers of contacts – 3.



CONCLUSION

The main way to improve the Passenger Transport System in Almaty is the intensive development of the high-speed off-street traffic network. The most promising type of such transport is the Metro. The proposed combination of the Ring Line and nine radial lines form the Developed network:

THE 1ST LINE –

THE EXISTING LINE, THE CONSTRUCTED RADIAL LINE and PLANNED LINES (23 stations, 14 interchange nodes): Kalkaman – Dostyk – Zhetsu – Saryarka – Moskwa – Sairan – Rozybakiev koshesi – Alatay – Auezov teatry – Baykonur – Abai – Almaly – Zhibek Zholy – Raiymbek Batyr – Seifullin dangly – Kotchin koshesi – Baumyn Togaiy – Zhumabaev koshesi – Tschernyshevsky koshesi – Wokzal Almaty-1 – Bekmakhnov koshesi – Beisembaev koshesi – Yntymak.

THE 2ND LINE –

THE PROPOSED RADIAL GREY LINE and THE PLANNED LINE (16 stations, 11 interchange nodes): Khan-Tengri – Kazakhfilm – Almagul' – Baikadamov koshesi – Gagarin dangly – Rozybakiev koshesi – Tole Bi koshesi – Kuderin koshesi – Severnoe Koltso koshesi – Zaria Wostoka – Dorozhnik – Tscheriomushki – Karasu – Pervomaisky – Esentai – Yntymak.

THE 3RD LINE –

THE PLANNED RADIAL LINE (15 stations, 10 interchange node): Orbita – Khodjanov koshesi – Zhandosov koshesi – Sairan – Tastak – Tole Bi koshesi – Aitiyev koshesi – Muratbaev koshesi – Gogol' koshesi – Zhibek Zholy – Kok Bazar – Baribaev koshesi – Ormanov koshesi – Orenburg koshesi – Duman.

THE 4TH LINE –

THE PROPOSED RADIAL ORANGE LINE (20 stations, 9 interchange nodes): Almalybak – Irgeli – Koksa – Algasbas – Akbulak – Ryskulov dangly – Kurylyssi – Severnoe Koltso koshesi – Bokeikhanov koshesi – Kazybaev koshesi – Przhevalsksy koshesi – Kotchin koshesi – Ulken Almaty Arnasy – Tatibekov koshesi – Atyray – Besagash – Tyzdybastau – Belbulak – Birlik – Kyzylkairat.

THE 5TH LINE –

THE PROPOSED RADIAL BLUE LINE (18 stations, 10 interchange nodes): Suranshy Batyr koshesi – Abishev koshesi – Baianaul – Aksai – Utegen Batyr koshesi – Tastak – Kuderin koshesi – Galiley koshesi – Alekseyev koshesi – Wokzal Almaty-2 – Raiymbek Batyr – Khamidi koshesi – Tatibekov koshesi – Kairat – Tereshkova koshesi – Guldala – Kuljinsky Trakt – Ibragimov koshesi.

THE 6TH LINE –

THE PROPOSED RADIAL YELLOW LINE (17 stations, 9 interchange nodes): Aksengir – Kokuzek – Boraldai – Boraldai-Auezhai – Uzhet – Dorozhnik – Kulager – Przhevalsksy koshesi – Seifullin dangly – Wokzal Almaty-2 – Gogol' koshesi – Karasai Batyr koshesi – Baykonur – Timiriazev koshesi – Gorny Gigant – Baiajanov koshesi – Tau-Samal.

THE 7TH LINE –

THE PROPOSED RADIAL GREEN LINE (24 stations, 12 interchange nodes): Kyrgauldy – Zhanaturmys – Akjar – Kamenka – Almaty koshesi – Mamyr – Taugul' – Altynsarin dangly – Zhandosov koshesi – Gagarin dangly – Atakent – Auezov Teatry – Muratbaev koshesi – Alekseev koshesi – Kazybaev koshesi – Kulager – Zhumabaev koshesi – Khmelknitsky koshesi – Zhas Kanat – Maiak – Almaty Auezhai – Almerek – Iliysky Trakt – Otegen Batyr.

THE 8TH LINE –

THE PROPOSED RADIAL CELADON LINE (18 stations, 8 interchange nodes): Zhapek Batyr – Ashibulak – Qoyankoz – Esentai – Beisembaev koshesi – Krasnogvardeisky Trakt – Altai – Zhas Kanat – Shemiakin koshesi – Ulken Almaty Arnasy – Dzhangildin koshesi – Khamidi koshesi – Kok Bazar – Kabanbai Batyr koshesi – Satbaev koshesi – Koktobe – Ospanov koshesi – Butakovka.

THE ALMATY METRO RING-RADIAL NETWORK
 (Prospects of creation and integration in the Urban Public Transport system)
Research Paper by GLEB K.SAMOILOV, 2014



Figure 31.
The Developed network
of the Almaty Metro.

Images source:

Drawing of the Almaty Metro Development proposals Author's – Gleb K.Samoilov (2013).

THE 9TH LINE –

THE PROPOSED RADIAL BROWN LINE (13 stations, 8 interchange nodes): Batysshil Saiabak – Kok-Kainar – Shanyrak – Uljan – Zaria Wostoka – Markelov koshesi – Bokeikhanov koshesi – Galiley koshesi – Aitiyev koshesi – Alatay – Atakent – Tramplin – Remizovka.

THE 10TH LINE –

THE PROPOSED RING RED LINE (26 stations, 18 interchange nodes): *Almaty-Auezhai – Tereshkova koshesi – Atyray – Duman – Shokai koshesi – Koktobe – Gornyi Gigant – Tramplin – Baganashil – Kazakhfilm – Navoi koshesi – Orbita – Taugul' – Zhetsu – Zhubanov koshesi – Aksai – Akbulak – Aigerim – Shanyrak – Darkhan – Uzhet – Tscheriomushki – Zhansugurov koshesi – Wokzal Almaty-1 – Krasnogvardeisky Trakt – Zhulduz*.

The Developed network of the Almaty Metro is shown in the Figure 31.

The Developed Metro network is the basis for creating an integrated system of the Public and the Private transport. This system will significantly reduce the length of trips by surface transport, reduces the number of units of the street traffic. This significantly reduces the amount of harmful emissions and improves the microclimate. The System of integrated Public and Private Transport, which is generated on the basis of the developed Metro network, will improve the accessibility of different urban land sites. As the result, significantly increase values of lands and investment attractiveness of the Almaty Conurbation.

The theme of the research has the prospects for expanding and deepening of the analysis:

- the separate research is needed for clarify the possibility of Metro track laying not underground, and in the recesses in the areas outside of the Ring line;
- for each Metro station (basically, may be only interchange nodes) be useful to determine the need of device the second lobby with escalators (in conjunction with elevators);
- it is interesting to study the interaction of bus routes in areas outside of the Ring Metro Line and trolleybus routes in areas inside of the Ring Metro Line;
- necessary to examine the accessibility of new Almaty urban areas in the south – large differences of landscape elevations on these sites exclude optimal Metro lines (possible bus express routes in conjunction with cable cars and funiculars, which are connected to stations of the Metro).



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